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PHOTO BY BOB GARVIN

MECHANICAL ANTS LEVELING HILLTOP

Overhead view of working brigade planing ground for Broome County Airport

VOLUME 53 • NUMBER 10

NEW YORK • LONDON

# Reduce Drill Maintenance Costs

## Get full protection against rust and wear with Texaco Rock Drill Lubricants EP

"GREATER footage, smoother operation," say drill runners. "Longer drill life, lower maintenance costs," say drill doctors. They're both talking about results from the use of *Texaco Rock Drill Lubricants EP*.

*Texaco Rock Drill Lubricants EP* have ample film strength to protect rifle bars, chucks and other moving parts under the toughest operating conditions. They resist oxidation and washoff . . . flow readily . . . and guard against rust whether drills are running or idle.

For *compressor* operation at its best, use *Texaco Cetus, Alcaid or Algol Oil*. They keep rings free, valves clean, air lines clear.

Let a Texaco Lubrication Engineer help with *all* your lubrication. Just call the nearest of the more than 2300 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

SEND FOR this new, illustrated, 32-page book: "Lubrication of Air Drills and Compressors." Packed with facts and practical suggestions to help you increase drilling efficiency and reduce costs.

TEXACO

# TEXACO Lubricants

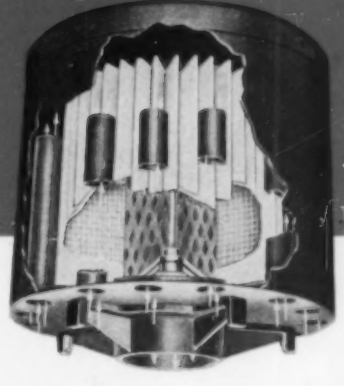
FOR ALL AIR COMPRESSORS AND TOOLS

Tune in . . . TEXACO STAR THEATRE every Wednesday night starring Milton Berle. See newspaper for time and station.

# IT FILTERS!

# IT SILENCES!

CUTAWAY VIEW



## STAYNEW MODEL DS INTAKE FILTER

Both silencing and filtering in a single compact unit! All the outstanding advantages of the original Staynew Dry-Type Radial Fin Construction: low resistance to air flow; increased efficiency with use; suitability for use on carbon ring compressors; no oil, viscous coating or charging tanks; no moving parts; inserts easily and inexpensively cleaned or replaced.

Silencing is efficiently handled without excess back pressure thru a series of cylindrical rectifying chambers of scientific diameter to length ratio.

Thousands of these well-designed, well-built Staynew Filters are already in use, saving wear on compressor and internal combustion engines, reducing intake clamor.

*FOR COMPLETE DETAILS WRITE:*

DOLLINGER PROTECTOMOTOR STAYNEW FILTERS

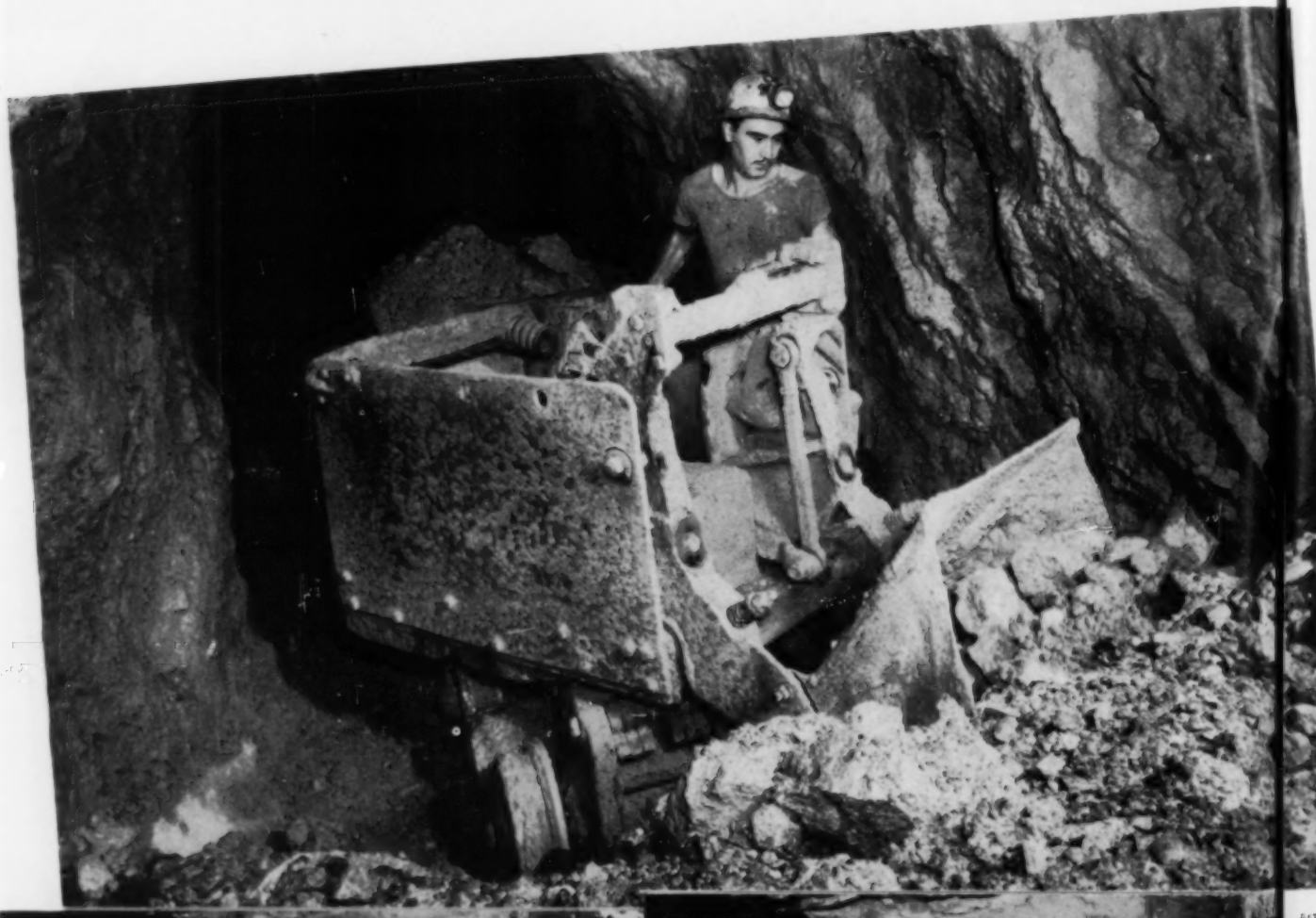
## DOLLINGER CORPORATION

7 CENTRE PK., ROCHESTER 3, N. Y.

*REPRESENTATIVES IN PRINCIPAL CITIES*

IN CANADA: McCarthy and Robinson, Toronto
Engineering Equipment Co., Montreal

# RockerShovels at United States Smelting,



# ng, Refining & Mining Co.

**The United States Smelting Refining and Mining Company uses RockerShovels to load their rock and ore underground. In crosscuts, shrinkage stopes and development headings the RockerShovels have been found dependable and economical in their operation. More than 50 RockerShovels are employed at the different U. S. properties.**

**The pictures shown are representative of the loading operations in several different U. S. mines. Many other mining companies have found that RockerShovels load faster with less maintenance cost than any other type of equipment. Call on Eimco to arrange for a demonstration or write for a catalog on RockerShovels.**

EIMCO

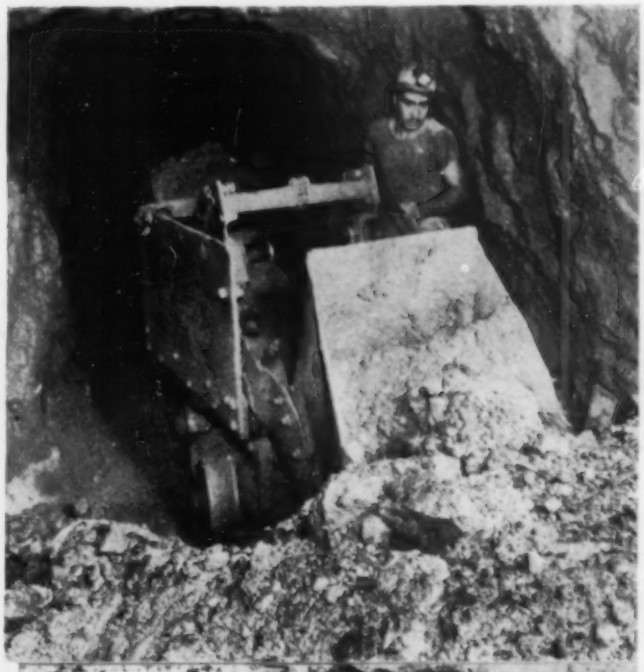
**THE EIMCO CORPORATION**

*The World's Largest Manufacturers of Underground Rock Loading Machines*

EXECUTIVE OFFICES AND FACTORIES — SALT LAKE CITY 8, UTAH, U. S. A.
BRANCHES: NEW YORK, CHICAGO, BIRMINGHAM, EL PASO, SACRAMENTO, MANILA
AFFILIATED COMPANIES: SOCIETE EIMCO, PARIS, FRANCE
EIMCO (GREAT BRITAIN) LTD., LEEDS 12, ENGLAND
AGENTS IN ALL PRINCIPAL CITIES THROUGHOUT THE WORLD

**Illustrations show Models 12B and 21 RockerShovels at work in western mine operations of United States Smelting Refining and Mining Company.**

A178



# WITH HANSEN COUPLINGS

**QUICK-CONNECTIVE COUPLINGS FOR**

- AIR
- ACETYLENE
- OIL
- GASES
- GREASES
- STEAM
- OXYGEN
- HYDRAULIC

## CONNECTION TAKES ONLY A SECOND

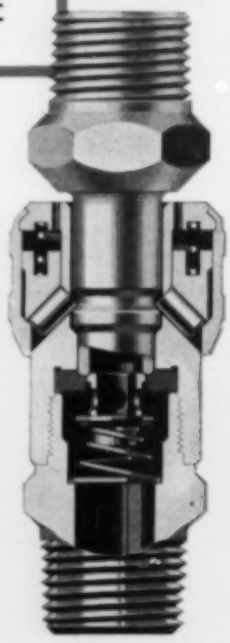
Threading fluid line couplings on and off to connect or disconnect is an unnecessary waste of time. Any line can be quickly and easily connected by using a Hansen Coupling. And, in addition, couplings have shut-off features that prevent loss of the liquid or gas in the line.

When you want to connect a Hansen Coupling, it is merely necessary to push the plug into place, where it locks securely. The valve opens, and flow starts instantly. The same operation disconnects—move the sleeve, and the plug pops out. Flow is shut off automatically.

From a wide range of available sizes and types you can select one suitable for any application. Air, oil, and gas, oxygen and acetylene, gasoline, hydraulic oil, and steam—each type of service has a Hansen Coupling engineered to meet its specific requirements.

If you have any fluid lines in your plant, you can increase efficiency, save precious minutes, by the use of Hansen Couplings.

*Write for industrial catalog No. 47 today*



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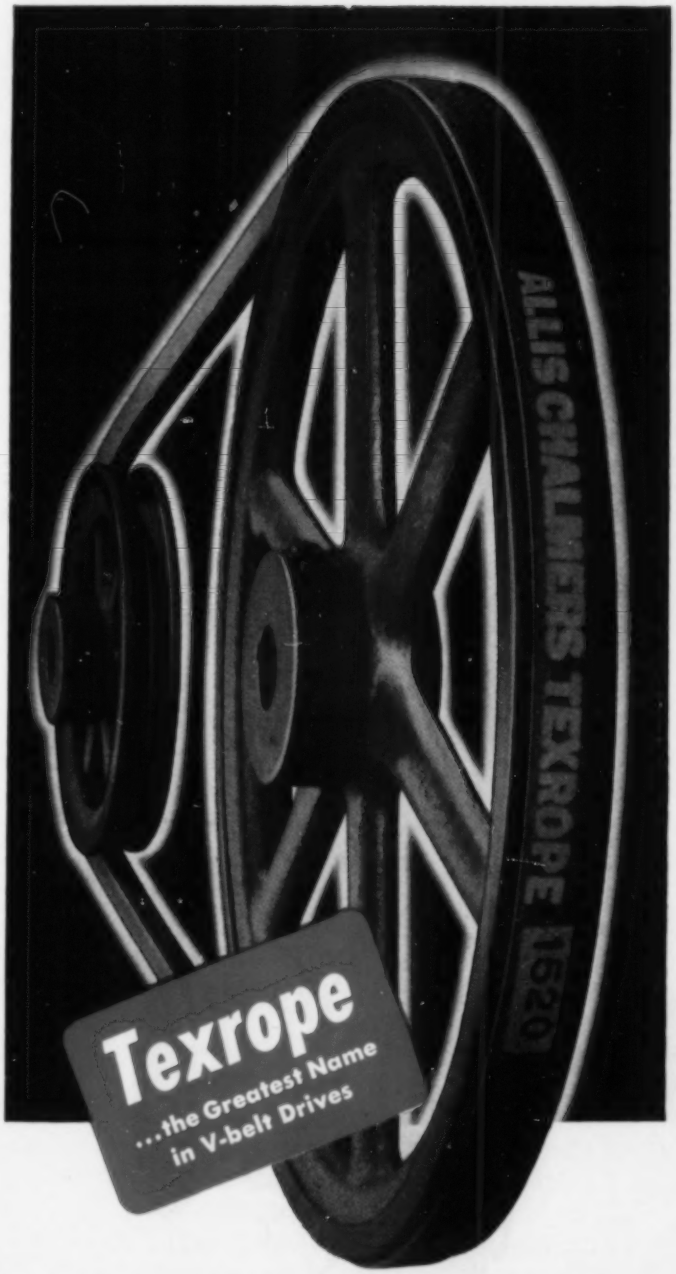
QUICK CONNECTIVE FLUID LINE COUPLINGS . . .

## THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 11, OHIO

# TEXROPE F/HP Drives




- "ENGINEERED" FOR INDUSTRY!
- AVAILABLE NOW!
- CARRY THE NAME "TEXROPE"... AND OVER 25 YEARS OF EXPERIENCE!

IF YOU'RE IN THE MARKET for fractional horsepower V-belt drives, here are good reasons for investing in TEXROPE — the greatest name in V-belt Drives. 1) They're "engineered" — selected and applied to suit the exact characteristics of your drive. 2) They're in stock at Authorized A-C Dealers or available promptly through A-C District Offices, and 3) They're backed by the greatest collection of V-belt drive experience and facilities of any company in this business.

### TEX-IRON F/HP SHEAVES

High density cast iron. Accurately bored for easy fit with tight shaft grip. Precision grooved for non-slip power and longer belt life. Carefully balanced for vibrationless operation at all speeds.

### TEXROPE F/HP V-BELTS

Best known name in V-belts. Carry full rated load with plenty of overload and shock load capacity. Molded to fit sheave groove and grip tightly without excess wear or wasted power. An ideal teammate for Tex-Iron sheaves. Highly efficient on present sheaves, too.

The complete range of Tex-Iron sheaves from 2 to 15 inches PD and Texrope V-belts to match are now available from your dealer's stock. Call him today. Texrope, Tex-Iron, Super 7, Texsteel, Magic Grip and Vari-Pitch are Allis-Chalmers Trademarks. ALLIS-CHALMERS, MILWAUKEE 1, WIS.

A 2510

**SEND TODAY** for Allis-Chalmers 44 page book No. 2086249A describing Texrope F/HP V-belt drives — the Fractional Horsepower Drive that's "Engineered" for Industry. Result of years of experience in engineering FHP V-belt drives. Shows you simple, accurate way to select FHP sheaves and belts. Every FHP drive user should have a copy.

| A Complete Range of Products | | |
|---|---|---|
| Super-7 V-belts | 5 types . . . sizes to suit every power transmission job | |
| Texsteel, Texdrive, Magic-Grip | Sheaves in a full range of sizes and grooves | |
| Vari-Pitch Sheaves | Exact variations in speed — Stationary or Motion control | |
| Speed Changers | Speed variations up to 375% at the turn of a crank | |

Texrope Super-7 V-belts result from the cooperative research of Allis-Chalmers and B. F. Goodrich; and are sold only by A-C dealers and offices.

# ALLIS-CHALMERS

*Originators of the Multiple V-belt Drive for Industry*

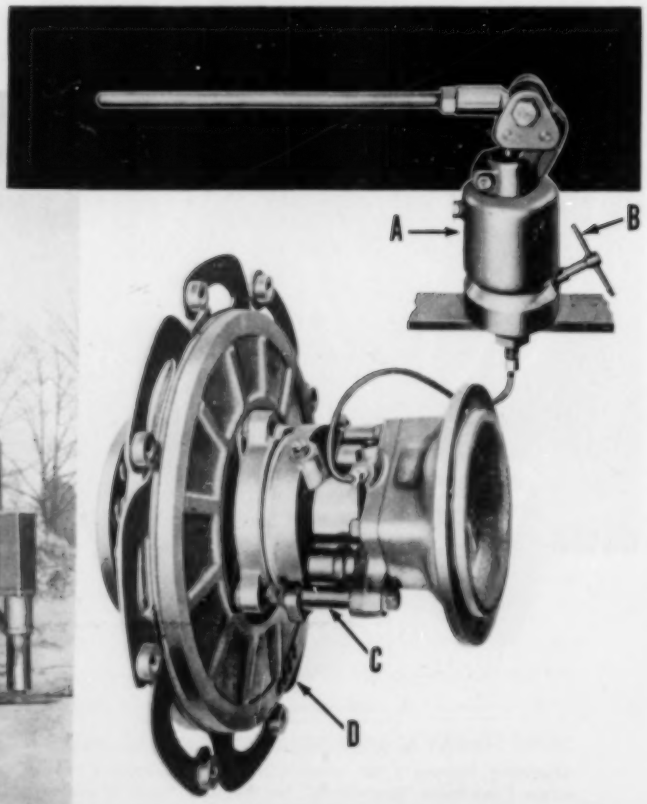
# NEW QUARRYMASTER HAS FLEX-DISC CLUTCH WITH HYDRO-SHIFTER

The new landmark of development work in the quarries, mines, and coalfields of 1948 is I-R's *Quarrymaster*.

This Paul Bunyan of rock drills takes on the large diameter holes which it drills fast and deep, and moreover can move under its own power from place to place. We show it here with tower erect in position for drilling in a Pennsylvania crushed rock quarry.

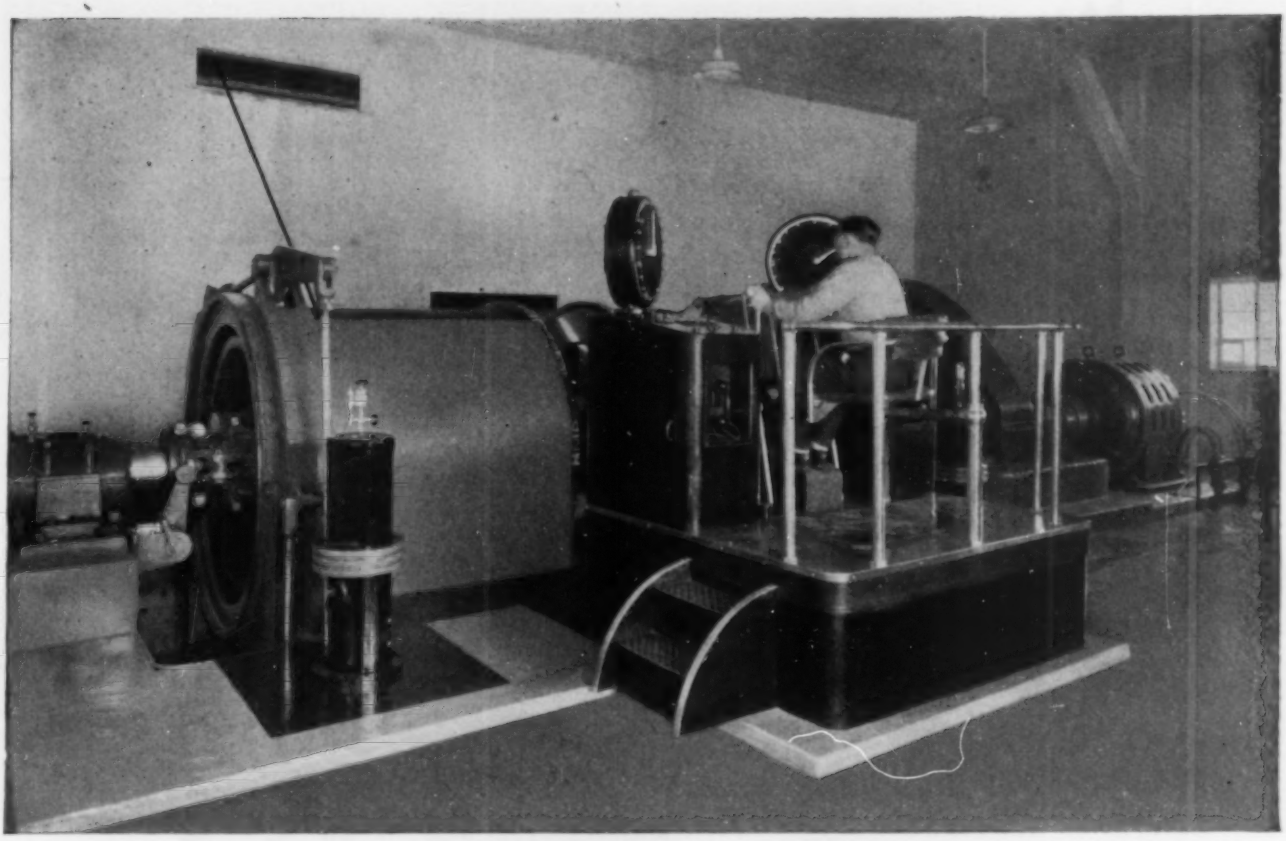
The Quarrymaster is equipped with the KA 500 *Mobil-Air* Compressor connected to the engine by a *Flex-Disc* Clutch with *Hydro-Shifter* for easy clutch operation in all seasons and at all altitudes. The principal features of the *Flex-Disc* Clutch with *Hydro-Shifter* (below) are:

(A) The pump reservoir (located wherever handiest) with handle for disengaging clutch in 2 or 3 easy strokes. (B) The release valve which engages the clutch by a slight turn. (C) The dual hydraulic jack unit with ball-bearing shift collar for long service, which actuates the clutch. (D) The *Flex-Disc* Clutch with its friction facings easily removable in segments for relining and replacing without disconnecting clutch from engine.




**INDUSTRIAL CLUTCH CORPORATION**

**Waukesha Wisconsin**



A Canadian Ingersoll-Rand Class PE-1 Single-Reduction Geared, Double Drum, Electric Hoist with Enclosed Platform Desk Controls at Powell Rouyn Gold Mines Limited, Noranda, Quebec.

# Mine Hoists . . . Pleasing in Appearance . . . Dependable in Performance

MINING MEN from many countries have remarked upon the pleasing appearance and efficient performance of hoisting equipment in Canadian Mines.

Such comments are a tribute to the ability and good housekeeping of mine mechanical staffs and to progressive ideas in manufacturing engineering.

The clean-lined design, enclosed controls and simplified construction of Canadian Ingersoll-Rand Mine Hoists are starting points for hoisting installations characterized by neat appearance, safety, utility and ease of operation.

The selection of a hoist which will efficiently handle today's loads and provide a margin for tomorrow's growth requires careful consideration and close co-operation. We will gladly help in planning such installations.

**Sizes manufactured for every service—from initial shaft sinking and light development work to the heaviest types of deep-level hoisting.**

**Further information regarding C-I-R Mine Hoists may be obtained from Ingersoll-Rand branches throughout the world.**

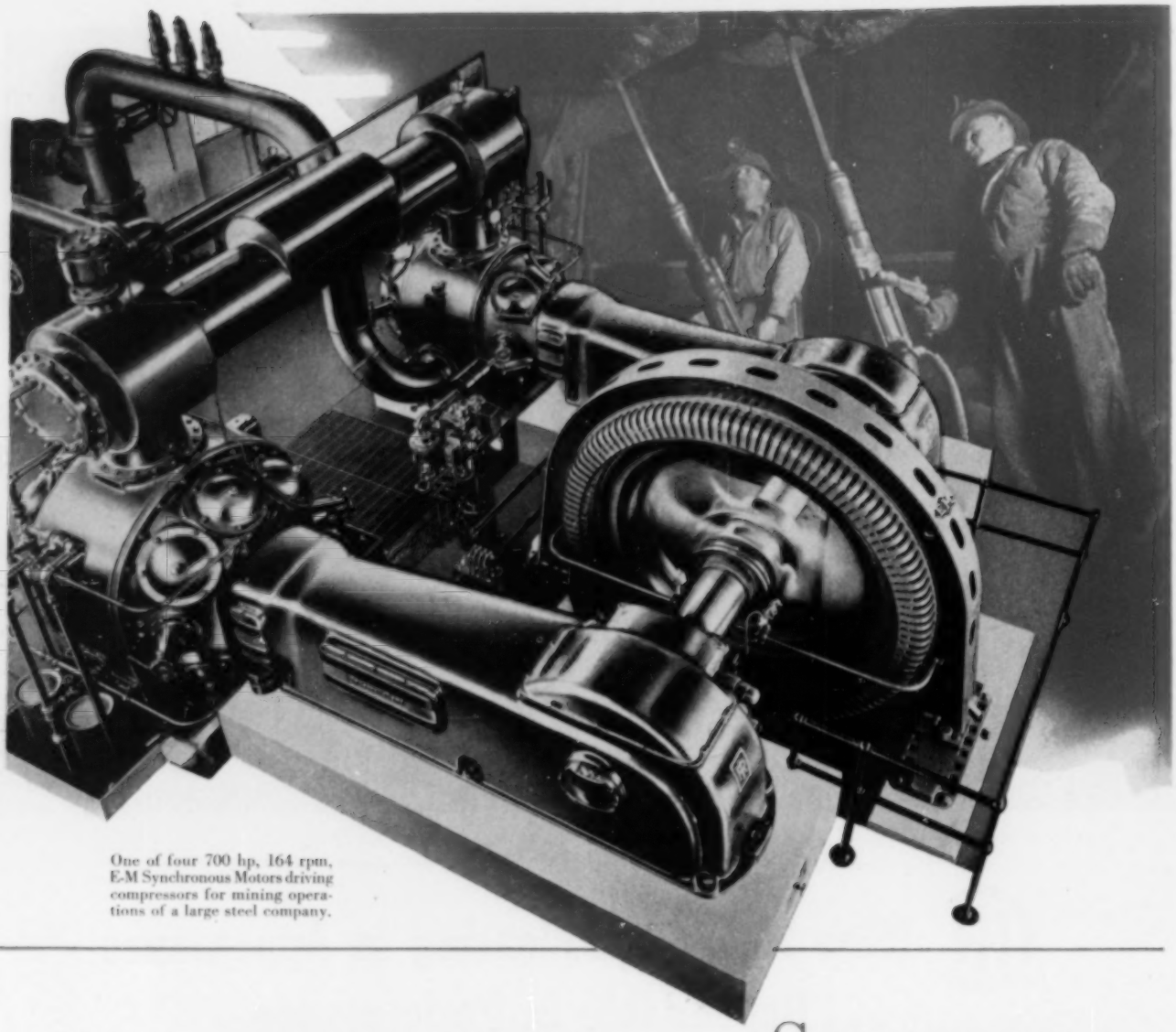
**Canadian Ingersoll-Rand Co. Limited**

*head office* - MONTREAL QUE. ——— *works* - SHERBROOKE QUE.

*branches at* SYDNEY - SHERBROOKE - MONTREAL - TORONTO - KIRKLAND LAKE - TIMMINS - WINNIPEG NELSON - VANCOUVER

K-9

AIR COMPRESSORS • ROCK DRILLS • HOISTS • PUMPS • BLOWERS • CONDENSERS • PNEUMATIC TOOLS



One of four 700 hp, 164 rpm, E-M Synchronous Motors driving compressors for mining operations of a large steel company.

# How compressor manufacturers **Save money**

## *. . . for the user of Air Power*

E-M

**SYNCHRONOUS MOTORS**
**are the first choice for**
**COMPRESSOR DRIVES**

●

**LOWEST COST** operation because of inherently efficient design.

**DIRECT DRIVE** for simplicity and minimum maintenance.

**HIGH STABILITY** to keep motors going despite voltage dips.

**HIGH POWER FACTOR** for preferential rates, improved voltage regulation.

**LOWEST INSTALLATION COST** for only two basic motor parts, stator and rotor.

**MAGNETIC CONTROL** with push button starting. "Conscious control", provided by Polarized Field Frequency Relay, cooperates with the motor for smooth starts.

● Leading compressor manufacturers, experienced in furnishing millions of horsepower, recommend Synchronous Motors for most efficient large compressor operation. They have found that the qualities of a Synchronous Motor mean real savings to the user of air power. That's why motor and compressor are designed and built with matching characteristics . . . and why the Synchronous Motor is the standard drive for large compressors.

E-M pioneered the development of the Synchronous Motor, was one of the first to apply its use to compressors. Today, E-M motors are used on a big share of all compressor drives. Their selection for such important jobs as the one pictured here is based largely on high efficiency and resultant savings.

Installation after installation confirms E-M Synchronous Motors' recognized dependability, wins for them their reputation as "the most efficient drive in industry".

**ELECTRIC MACHINERY MFG. COMPANY**
**MINNEAPOLIS 13, MINNESOTA**

E-M

A2049

# FOR LEAKPROOF, TROUBLE-FREE PIPE RUNS

*Cut-a-way view of a Walseal Tee showing ring of silver brazed alloy, and completed Silbraz joint.*

**Specify Walseal* Products**

On all types of piping jobs where Type "B" copper or red brass pipe is used, trouble can be avoided by installing Silbraz* joints — made with Walseal valves, fittings and flanges.

Threadless, patented Silbraz joints are silver brazed (not soft soldered) pipe joints that are leakproof, trouble-free — permanent ... connections that will not creep or pull apart; that literally join with the piping system to form a "one-piece pipe line". Thus, these modern joints eliminate the need for maintenance and costly repairs — especially important where lowered operating costs are imperative.

For complete details on the modern Silbraz joint, made with Walseal products, write for a copy of Walworth Circular 84.

**Patented — Reg. U. S. Patent Office.*

***Recommended for***

- **Hot and Cold Water Circulating Systems**
- **Boiler Feed Lines**
- **Steam Return Lines**
- **Condensate Lines**
- **Low and High Pressure Air Systems**
- **Lubricating Oil Circulating Systems**
- **Industrial Gas Piping**
- **Solvent and Vacuum Piping Systems**

***Make it a "one-piece pipe line" with WALSEAL***

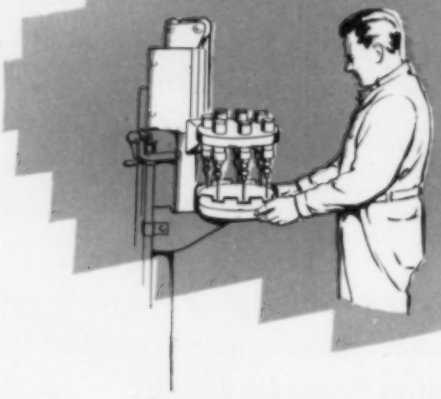
# WALWORTH

## valves and fittings

**60 EAST 42nd STREET, NEW YORK 17, N. Y.**

*Drilling Job*

*Made* ***EASIER*** *and* ***86% FASTER***

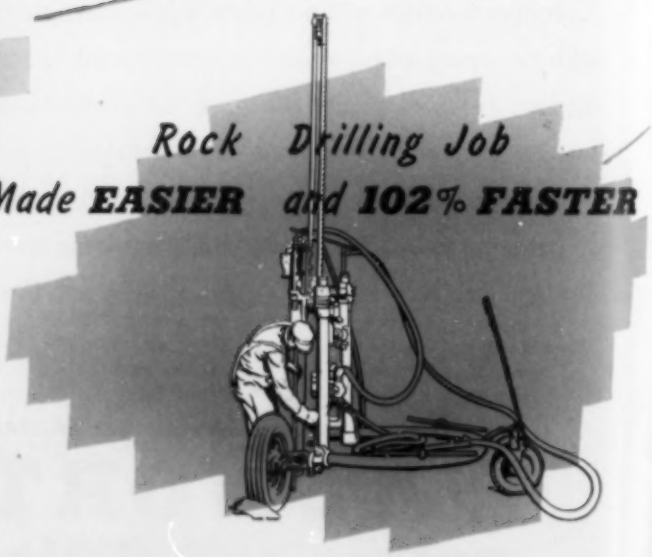


*Screw Driving Job*

*Made* ***EASIER*** *and* ***67% FASTER***

*Rock Drilling Job*

*Made* ***EASIER*** *and* ***102% FASTER***



**These examples show the time in which typical I-R AIR POWER EQUIPMENT paid for itself in actual use because AIR TOOLS enable the workman to produce more with less effort.**

# makes jobs Easier

## *with equipment that pays for itself nearly twice as fast today!*

Air Power makes jobs easier because Air Tools are light, fast, less tiring to use, take less effort to handle and control.

Since Air Tools enable the workman to produce more with less effort, it is easy to speed operations, and get more production. At the same time, under today's conditions, Air Power equipment pays for itself almost twice as fast as it did a few years ago.

**For instance, drilling holes for cover lugs of pressure cookers is 86% faster in one plant now that I-R Air Tools are used.**

**Driving hundreds of screws into railroad cars is much easier, and 67% faster, with Air Power at work.**

**Rock is drilled 102% faster, with less operator fatigue, when I-R Air Power equipment is on the job.**

Ask your I-R branch office to arrange for a job study in your plant. Actual tests of Air Tools and Equipment will be made on your own operations, so you can determine definitely how much you can save in production costs, and the period of time in which recommended equipment will pay for itself.

AIR POWER
*The Key to Lower Production Costs*

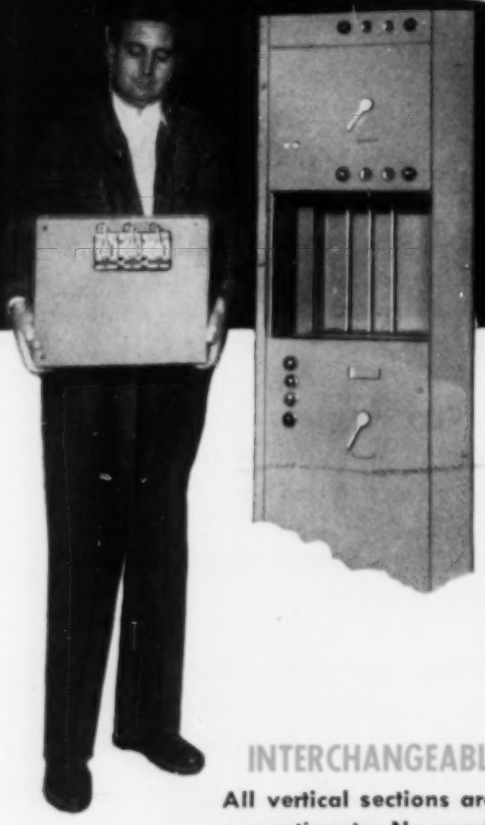
**Ingersoll-Rand**

11 Broadway, New York 4, N. Y.

# "Clothespin Contact"...

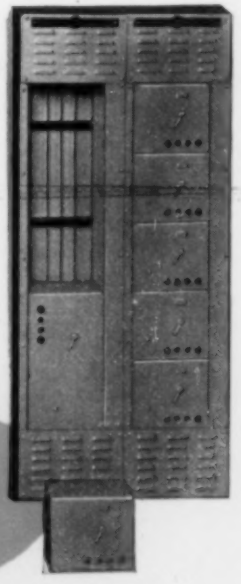
## in the new G-E Motor Control Center

## marks new advance in starter design



No wiring from starter to bus necessary with this new feature. Simply put the starter in place . . . . and the stabs automatically engage the bus bars in quick, positive connec-

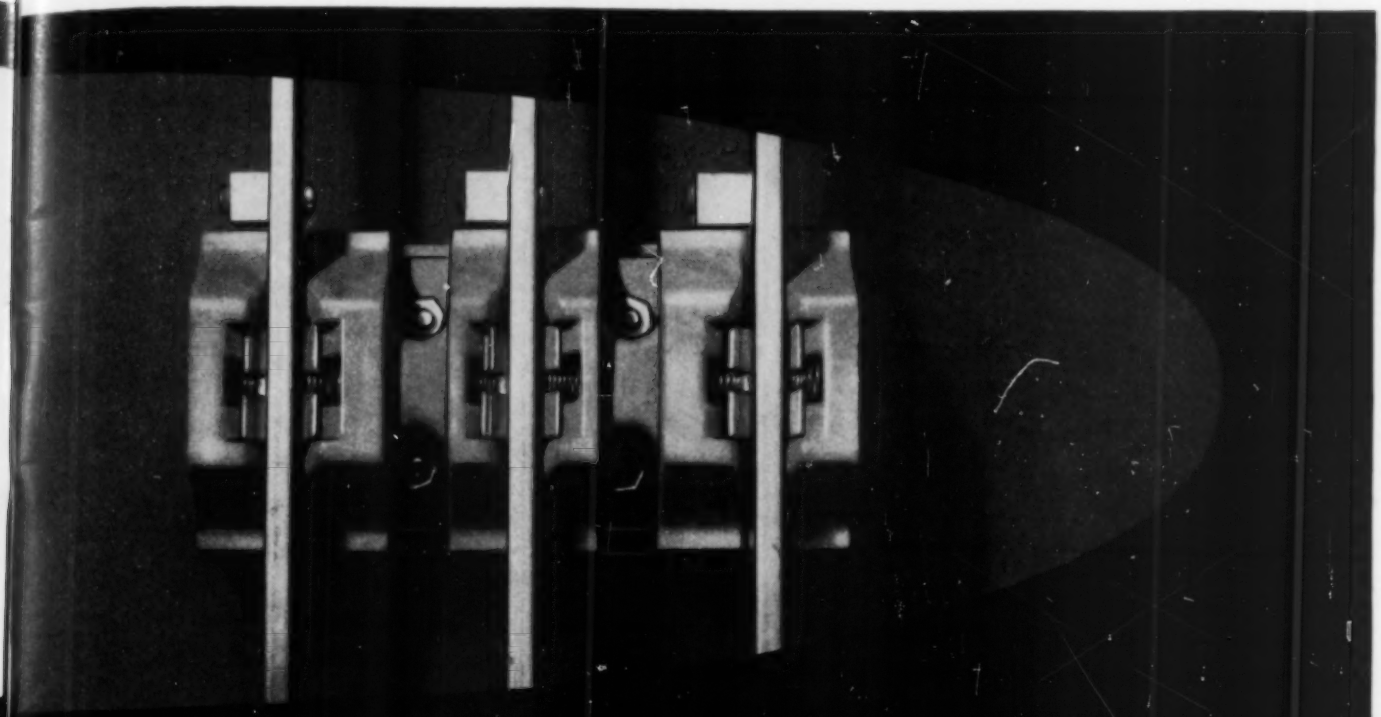
**SAVES SPACE** This compact centralized motor control system permits you to put all of your control in one spot—simplifies installation, interconnections, and maintenance. Control centers are only 12 inches deep, all wiring is front-connected so units may be placed back to back, in an "L" shape or flush against the wall.



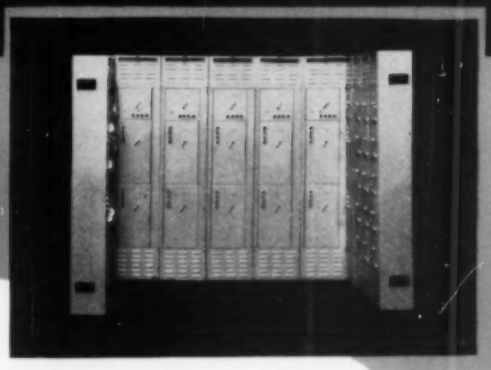
**INTERCHANGEABLE**

All vertical sections are the same size, all starter units are proportionate. No special engineering is necessary to plan your own G-E control center. To make it even simpler—starter units for motors from 1 to 25 horsepower have the same overall dimensions.

GENERAL ELECTRIC

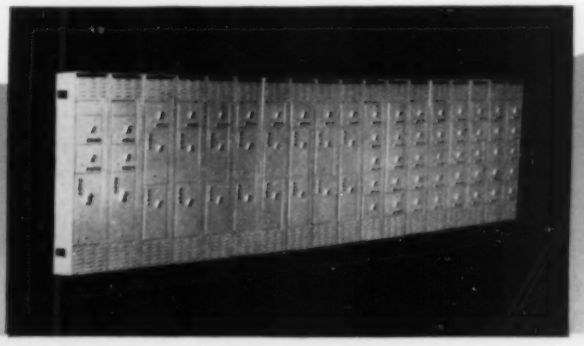


tion. For emergency handling, the starter can be removed without de-energizing the power bus after a simple removal of the supporting bolts.

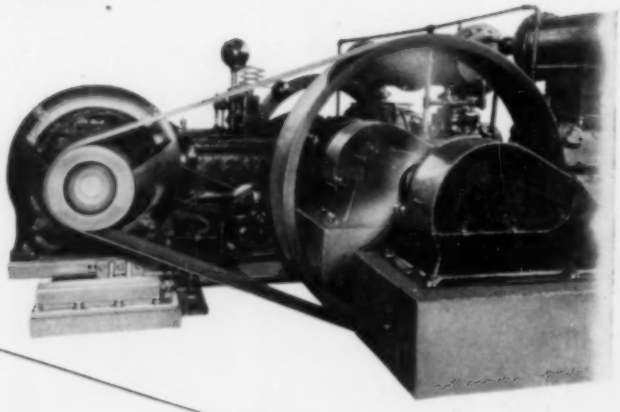


## PLAN YOUR OWN G-E MOTOR CONTROL CENTER

**Contact our sales engineer at the nearest G-E office for copies of an easy-to-use planning chart—or write us for bulletin GEA-4979 which contains additional information.** ***Apparatus Dept., Section 676-263, General Electric Company, Schenectady, New York.***



# What makes life easier for this compressor drive . . .



Here are close-ups of two things that lengthen a compressor drive's life by making its job easier.

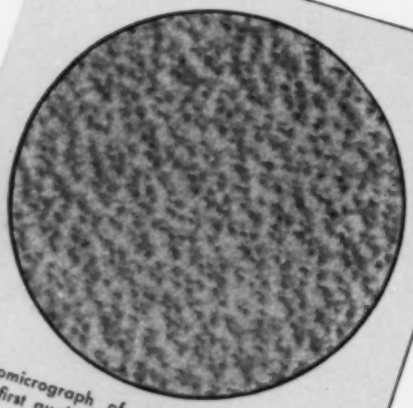
### PULLEY GRIP

The clean, uniform, pore-like surface of a first quality leather belt provides a pulley gripping capacity that enables the belt to carry heavy loads at lower tension.

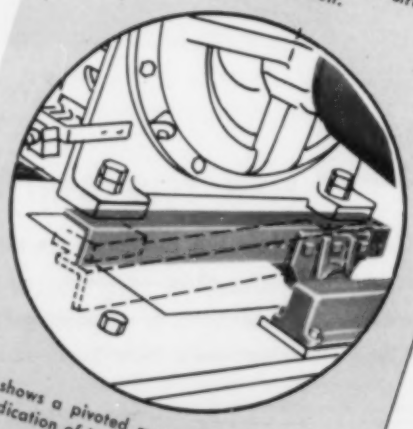
### AUTOMATIC TENSION CONTROL

The pivoted motor base gives instantaneous compensation in belt tension for changes in load. It makes the belt "lean" into the heavy loads; then lets it "relax" to the minimum tension required, when the load returns to normal.

Together, the first quality flat leather belt and the pivoted motor base drive the compressor with minimum strain . . . reducing wear on bearings and belt.



Photomicrograph of the surface structure of a first quality leather belt.



This shows a pivoted motor base and gives an indication of how it functions.

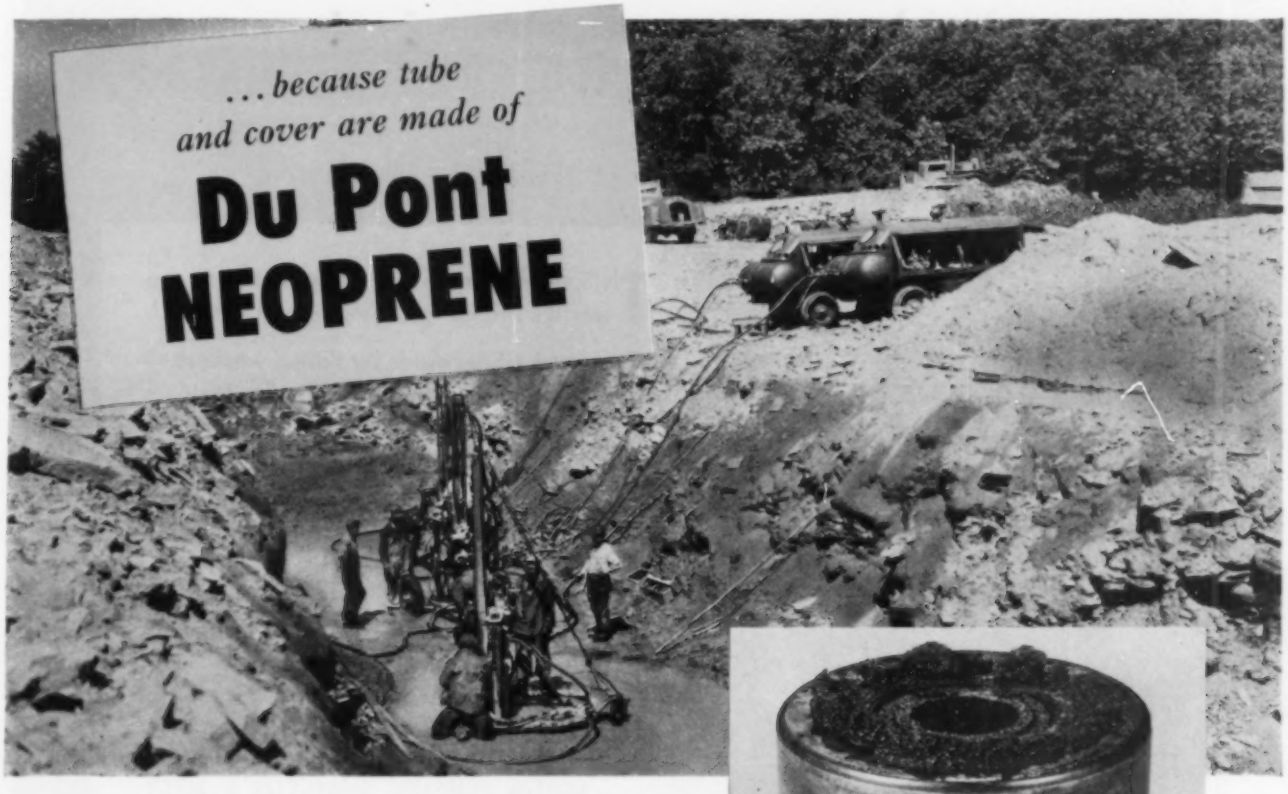
AL-20

**American LEATHER BELTING Association**

***Headquarters for Authentic Power Transmission Data***

**41 PARK ROW, NEW YORK 7, NEW YORK**

# Out on construction jobs this air hose withstands heat, oil, weathering and abrasion




In the most severe service encountered, this air hose stands up. For both inside and out . . . it's protected with tough, durable neoprene.

**The neoprene tube** won't disintegrate when exposed to hot lubricating oil. So no crumbled particles or chunks will be carried along to clog the tool (as shown at right). And neoprene not only prevents tool clogging. But, because it retains its strength and toughness, it constantly protects the fabric reinforcement from oil, heat and moisture which rot the fabric and lead to blow-outs.

**Cover is made of neoprene, too.** Even broiling summer sun, driving rains and icy winter temperatures won't make neoprene crack or soften. And a neoprene cover can take the punishment of yanking and dragging it over sharp rocks and rough debris. For neoprene withstands cutting, chipping and abrasion.

So make sure of long service life . . . low replacement costs on the air hose you use. Ask your supplier for hose made with neoprene tube and cover. A neoprene hose stands up in the toughest service year after year.

E. I. du Pont de Nemours & Co. (Inc.), Rubber Chemicals Division Y-9, Wilmington 98, Del.

**Neoprene prevents breakdowns like this!** Valve chest and valve from an air tool have become clogged with particles of the tube, which has disintegrated from oil and heat.

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

SPECIFY HOSE MADE OF

NEOPRENE

The rubber made by Du Pont

# The Symbol of QUALITY in Grinding Wheels . . .

**NORTON ABRASIVES**

THIS symbol means a wheel made in the world's largest grinding wheel plant.

It means a wheel made by skilled workers — 10% of them Norton employees for 25 years or more.

It means a wheel backed by the most extensive research facilities in the grinding wheel industry.

It means a wheel especially suited to each of your grinding jobs — expertly selected by one of the country-wide staff of Norton abrasive engineers.

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## ON THE COVER

OUR cover picture gives an idea of the concentration of mechanized mobile equipment on large modern excavating operations. It shows the opening of the mass attack to shear off the summit of Mount Ettrick in New York State in building the airport described in the article beginning on Page 234. The job entails the movement of more than 2½ million cubic yards of earth and rock. The irregular line at the upper right, partly in shadow, is the working face where the rocky crest of the eminence is being drilled, blasted, and loaded by power shovels. Elsewhere, the mantle of overburden is being scooped up by huge self-loading scrapers and other machines. Their tracks make an interesting but jumbled pattern. All spoil is transported to low-lying areas, and the haulage entails thousands of miles of travel.

•

## IN THIS ISSUE

THE GROWTH in air travel has boosted airport building into a place of prominence in the construction field. The equipment and techniques used are similar to those of the roadbuilder, the main difference being that the former work is more localized. Our leading article describes the construction of the Broome County (N. Y.) Airport which will provide three small but important industrial cities with aerial-transport ground facilities of the latest type.

•

THE Calyx core drill is growing in stature as an engineering and construction tool. As its field of application broadens, new uses are being found for large-size outfits. Numerous units that cut 48-inch cores are now in service, and there are indications that 6-, 8-, and even 10-foot cored holes will be fairly common in the near future. An article starting on Page 238 contains a roundup of information on the status of this adaptable piece of equipment.

•

FOUR years ago we described a huge project designed to lower the water in Steep Rock Lake, Canada, to expose iron deposits lying beneath its bed. The effort was successful and large-scale mining is now in progress, as outlined in this issue. Page 244.

•

AN IMPROVED type of bear-trap spillway gate that is made buoyant by compressed air is a feature of Possum Kingdom Dam in Texas. The designer describes it in an article (Page 247) that also includes a historical sketch of disappearing spillway gates.

•

SHERMAN HILL ballast has long been familiar to railroadmen of the West. Material from this high point in the Union Pacific system has been transported hundreds of miles and by the thousands of tons. Its production now constitutes a huge quarrying operation that is described in an article beginning on Page 250.


# Compressed Air Magazine



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# Carving an Airport from a Mountain Top

*W. P. Gillingham*

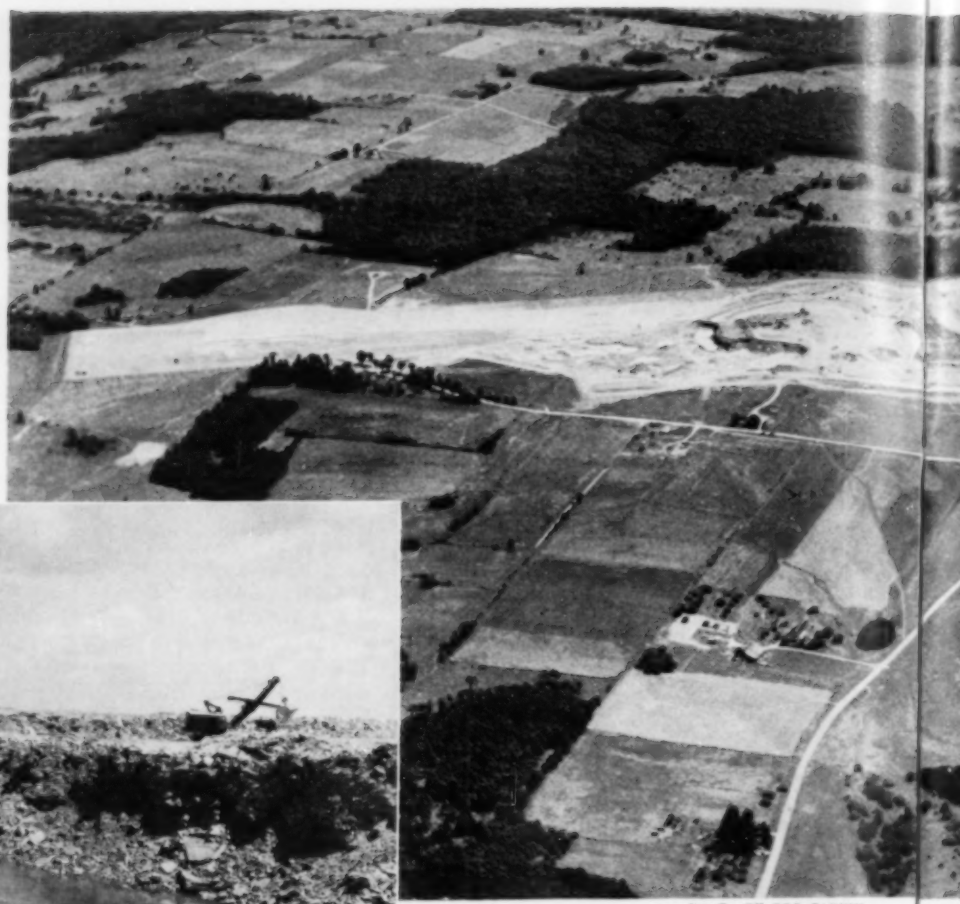
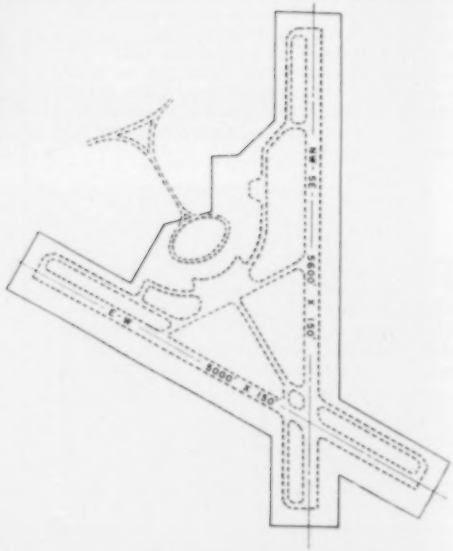


PHOTO BY BOB GARVIN



**GENERAL VIEWS AND PLAN**

The two main runways of Broome County Airport are clearly defined in the aerial view at the top-center. The large mound nearly in the middle of the horizontal runway is the crest of Mount Ettrick. As pictured directly above, it is being removed in a series of horizontal slices or benches. At the right is a plan of the airport. The solid lines enclose the area that is being graded to the level established for the field, while the dotted lines indicate the sections that are to be paved when grading is completed. The administration building, hangars, and other structures will be erected around the oval driveway, which is designed to handle all vehicular traffic to and from the airport. Not shown in the drawing is a shorter turf runway that will connect the two main runways at a point approximately midway.

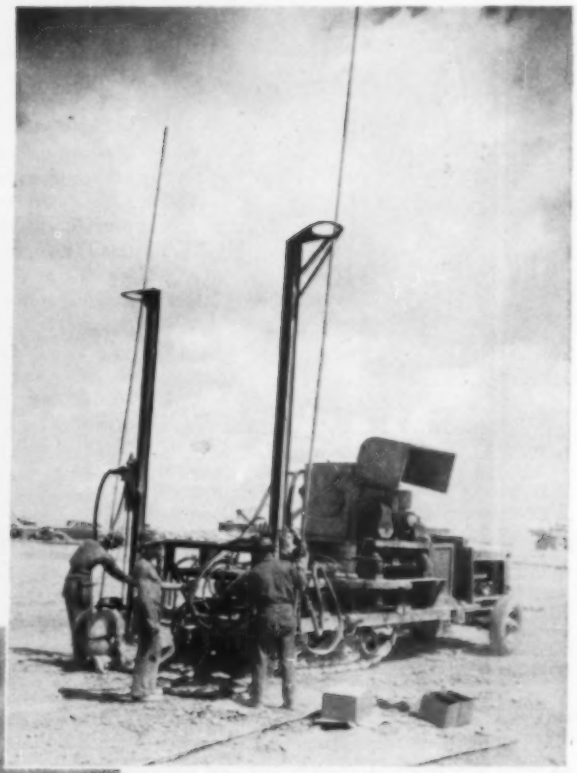
AIRPLANE pilots usually try to avoid mountains while in flight, but over Broome County, N. Y., they may soon be seeking one with the avowed intention of landing on it. The object of their search will be Mount Ettrick—a 1670-foot-high formation near the neighboring cities of Binghamton, Endicott, and Johnson City. Construction of a multimillion-dollar airport on the mountain is being carried out by Broome County and the Civil Aeronautics Authority, cosponsors of the project, and the contractor's crews have been engaged for several months in knocking off the top of the elevation. Of particular interest in their operations is the novel method employed for drilling blast holes in a ledge of rock encountered in the excavation work.

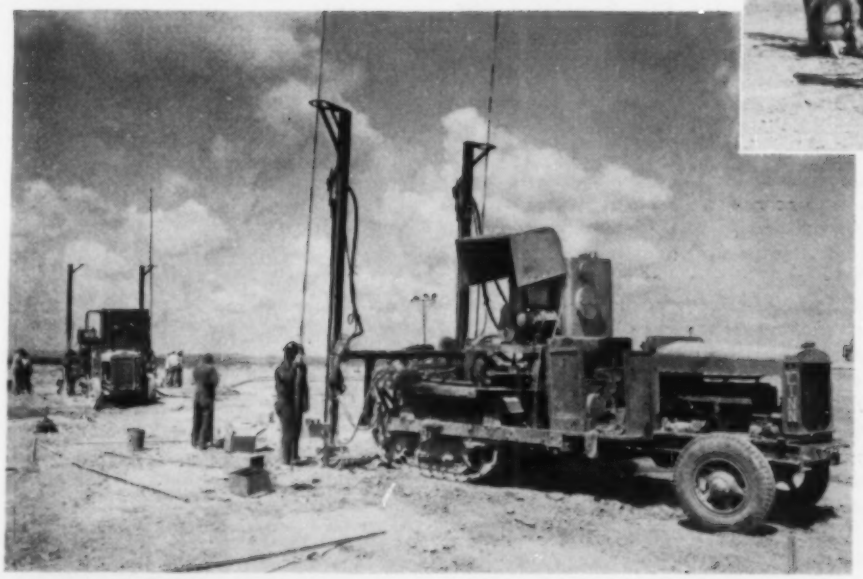
Broome County has a population of some 166,000 persons, of whom approximately 114,000 live in the three cities just mentioned. Binghamton, with a population of 78,000, is the county seat. It is on the Susquehanna River and is an important railroad and industrial center. Nearby Endicott and Johnson City have a combined population of 36,000 and are the homes of such manufacturing concerns as International Business Machines Corporation, Endicott-Johnson Corporation, and others. All told, some 40,000 persons in the Tri-City area are employed in industrial plants, and other thousands are engaged in farming and other activities.

The industrial importance of the Tri-City section, its large population, and the number of travelers who visit the communities each year have emphasized the need for adequate air service. The only airport now operating in the immediate vicinity is at Endicott. Although sufficient as to size, it is unsuited for use by major airlines because of fre-

**DRILLING OPERATIONS**

The lowermost picture shows two of the three drill carriages improvised by the contractor for putting down blast holes in the rocky crest of Mount Ettrick. Mounted on the mid-section of the near truck is a suction device for collecting dust created by the drilling operations. The drillers in the view directly below are preparing to remove 24-foot lengths of steel from the drills and to substitute for them the 30-foot lengths that are seen extending up through the retaining collars. This simple attachment on a drill tower makes it unnecessary to lay each piece of steel full length on the ground after use and to pick it up again when it is needed.





quent river and valley fogs and also because of hills and other obstructions that present hazards to large planes landing on or taking off from the field.

Recognizing that the lack of an adequate airport was unfavorable to the continued growth of the region, Broome County officials took steps to construct an all-weather flying field in an area free of such obstructions as high-tension wires, buildings, church spires, etc., yet close enough to the three cities to serve all the residents conveniently. An 850-acre site atop Mount Ettrick was selected as the one among the available locations that best meets these requirements. The mountain is approximately nine miles from Binghamton and eight miles from Endicott. The site is well above the fog line and is practically free of obstructions that might constitute hazards to flying aircraft.

After preliminary plans for the proposed airfield had been drawn up, application was made to the Civil Aeronautics Authority for Federal funds to aid in its construction. The CAA, with a backlog of 210 million dollars in requests for airport allocations, received a Congressional appropriation of 40 million dollars for the current year starting July 1. Of these funds, $35,098,459 has been earmarked for a $73,819,455 airport-development program which will benefit 455 communities scattered throughout the 48 states and the territories, the CAA meeting approximately half the cost of each project and the remainder being provided by local sponsors. Recipients of the funds are selected according to a formula based on area and population. The Mount Ettrick Project was granted top priority by the CAA, being considered of immediate aeronautical importance.

The field will have three runways: two main ones and a secondary strip, all 150

**LOADING BLAST HOLES**

Blasting crews working behind each drill carriage load the holes with dynamite. At the close of the day's activities, the charges are fired simultaneously to remove a mass of rock approximately 30 feet wide and extending the full length of the ledge.

feet wide. The longest of the first two will run northwest-southeast for 5600 feet. Its companion, 5000 feet long, will run east and west. The secondary runway, 2300 feet long, will extend northeast-southwestward, connecting the two longer ones about at their midsections, and will be used by light planes. The total cost of the project, including grading and paving of the two main runways, grading and turfing of the secondary strip, and providing the necessary buildings, hangars, parking strips, etc., is estimated at around $4,000,000. The CAA is matching the county's appropriations on all the items except that of land acquisition, towards which the county pays 75 percent and the CAA 25 percent.

Before actual construction was begun, some 28 separate studies of the site were made to determine the final location of the runways and the grade to which the surface was to be leveled. The location selected was such that the crest of Mount Ettrick lay near the center of the line for the 5600-foot runway. The surrounding area sloped gently downward in all directions from the apex of the mountain except for two knolls, one at the western end of each of the two main runways. The elevation of the field was established at a level 62 feet below the highest point, and all material lying above this plane was to be removed and transported to fill areas to bring them up to grade. The grade line was chosen so that cut and fill quantities would approximately balance.

Bids were then asked for the clearing, grading, and drainage of the site, a task that called for the excavation of 2,600,000 cubic yards of earth and rock. D. W. Winkelman Company of Syracuse won the contract on a low bid of $1,968,627, which was $233,085 under the estimated cost. The contract was signed on May 1 and shortly afterward a crew of 175 men, equipped with 55 power units, began to level off the top of the mountain.

Although May 1, 1949, is the date set in the contract for the completion of the grading operations, the advent of winter may, perhaps, make that work impossible. Accordingly, grading is being pushed at a rate that is calculated to finish the major part of it by October 31, leaving the remainder such as trimming and cleaning up until spring. Included among the present power units on the job are five 2½-cubic-yard shovels, one loader, ten end-dump and eighteen bottom-dump trucks, six scrapers, twelve bulldozers, four sheep's-foot rollers, two 3-wheel rollers, three motor graders, one grease truck, and one fuel truck. The power units are operated two 10-hour shifts a day, illumination for the night shift being furnished by portable generators. Fuel and grease trucks operate 24 hours a day to keep the earth-moving machines on the go. Altogether, the various pieces of equipment are moving some 23,000 cubic yards of earth and rock a day.

Removal of the two smaller knolls presented little difficulty, but the crest of Mount Ettrick was not so easily taken off. Underneath some fifteen feet of overburden was a ledge of rock of which approximately 800,000 cubic yards was above grade and had to be excavated. The rock is a shale of medium hardness and of uniform composition. Ordinarily, its excavation would call for conventional methods of drilling and blasting, using wagon drills to put down the blast holes. However, the uniform composition of the shale and the shape and flat-lying nature of the formation permitted the adoption of a rather unusual method of drilling.

Three Linn halftracks—trucks with pneumatic-tired wheels in front and crawler treads in the rear—are used as movable drill carriages. On the back end of each of them is a horizontal bar mounted about 5 feet above the ground. It is held in position by vertical I-beam columns welded to it and bolted to the truck bed and is braced by sections of angle iron secured in a similar manner. Two Ingersoll-Rand Type DBM-3 drill mounts are fastened to the outer ends of the bar for use in drilling vertical holes. In addition to this bar, one truck is also equipped with a second and lower bar for use in drilling horizontal holes in the vertical sides of cuts made in the shale bed.

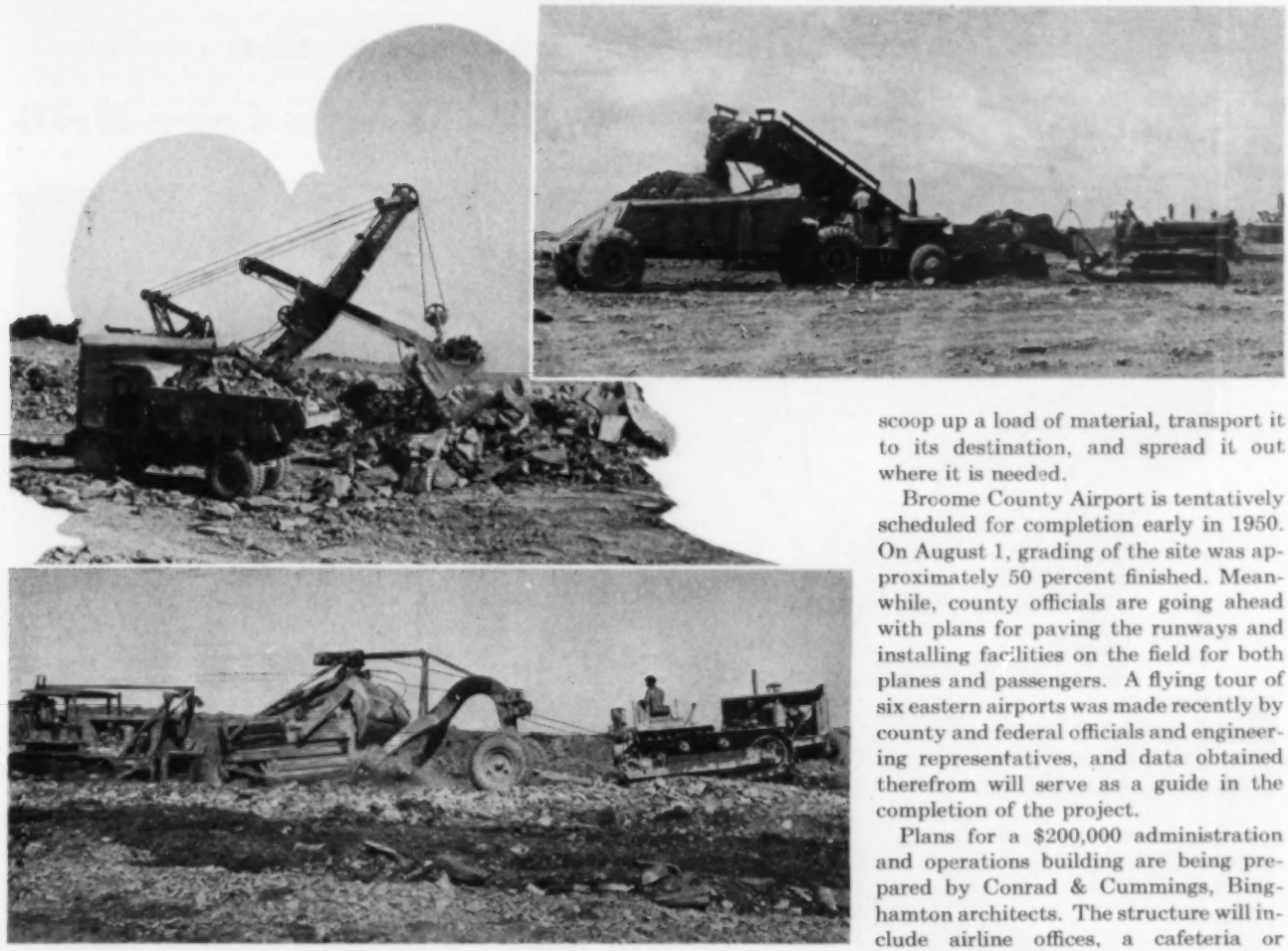
The DBM-3 is a drilling and broaching mount carrying an X-71 drifter drill and having a normal length of feed sufficient to permit making 9-foot steel changes. For this particular job, however, the towers of four of the drill mounts were lengthened so as to provide for 12-foot steel changes. Three lengths of steel are being used for most of the drilling: a 12-foot, a 24-foot, and a 30-foot length. A cup-shaped holder mounted on a brace near the bottom of each drill tower and a retaining collar on the top enable the sections of drill steel to be handled and used with a minimum of effort and to be moved along with the truck as it advances.

Compressed air is supplied to the drilling units by five portable compressors having a combined capacity of 1470 cfm. at a pressure of 105 psi. They discharge into a common receiver, from which two pipe lines extend to the area being drilled. From the ends of the lines, air is supplied to the drill carriages by hoses that are long enough to permit each rig to operate within a fairly large radius. From time to time, the compressors, receiver, and delivery lines are moved to keep up with the advancing drills. The air pressure at the drills is 90 psi. and more.

The locations of the drill holes are

**PORTABLE LIGHTING UNIT**

Grading operations do not cease with the coming of night. Twenty of these skid-mounted, self-contained lighting units provide the illumination needed to keep the earth-moving equipment rolling from dusk till dawn.



**MOVING EARTH AND ROCK**

A considerable number of heavy earth-moving units is being used in the grading operations. Rock broken by the previous day's blast is loaded into trucks by power shovels. At the upper left is shown a Northwest shovel about to dump a 2½-cubic-yard dipperful of broken material into a waiting Euclid truck. In the lower view, a bulldozer gives a friendly push to a tractor-drawn Le Tourneau Carryall scraper that is scooping up a load of earth and rock for removal to a fill area. Overburden and other unconsolidated material are handled by a Euclid loader (upper-right). This tractor-pulled device loads continually into bottom-dump trucks that come up alongside one after another.

staked out in advance of the drilling operations. Holes are spaced on 12-foot centers and in most cases are drilled to a depth of from 25 to 28 feet. The two drilling units travel along the line of stakes in tandem fashion, drilling at alternate locations. A truck is first maneuvered until its drills are in proper alignment with the stake at that particular spot. Drillers next loosen the vertical swing bolt of each drill tower and adjust the latter until it is vertical. Bolts are then tightened and drilling begun, using 12-foot lengths of drill steel. When each steel has drilled to its full length, it is withdrawn from the hole, lifted up through the collar and its bit end set in the holder, and the next-longer piece of steel is removed from the holder and dropped into the hole. When the two holes have reached the proper depth, the truck is advanced to its next position and the procedure is repeated. With these drill carriages, drillers have been able to average 80 feet of hole an hour with each drill. Size 2⅜-inch Jackbits are used, each bit drilling roughly 40 feet of hole before becoming dull, when it is shipped with others to Syracuse for resharpening.

As soon as a drill rig has completed its two holes at a given location and been moved ahead to a new one, the blasting crew loads the holes in preparation for firing. Dynamite of 30 and 40 percent strength is used. The holes are filled solidly to within 6 feet of the top, long wooden poles being used to tamp the explosive firmly in place. The remainder of the hole is then filled with stemming. Blasting is done at the end of each day's drilling activities, using electric detonators for firing. The material thus broken is loaded by power shovels into trucks and transported to areas of fill, where it is compacted by rollers and by the passage of heavy vehicles over it. Some of the broken rock is removed by scrapers that scoop up a load of material, transport it to its destination, and spread it out where it is needed.

Broome County Airport is tentatively scheduled for completion early in 1950. On August 1, grading of the site was approximately 50 percent finished. Meanwhile, county officials are going ahead with plans for paving the runways and installing facilities on the field for both planes and passengers. A flying tour of six eastern airports was made recently by county and federal officials and engineering representatives, and data obtained therefrom will serve as a guide in the completion of the project.

Plans for a $200,000 administration and operations building are being prepared by Conrad & Cummings, Binghamton architects. The structure will include airline offices, a cafeteria or restaurant, postal service, a CAA office, an express and air-freight office, a weather bureau, and luggage and rest rooms. A deck or promenade may be erected from which travelers and others could watch planes landing and taking off. County officials are also considering a plan to develop a park and recreational area for use by visitors who like to watch but don't fly themselves.

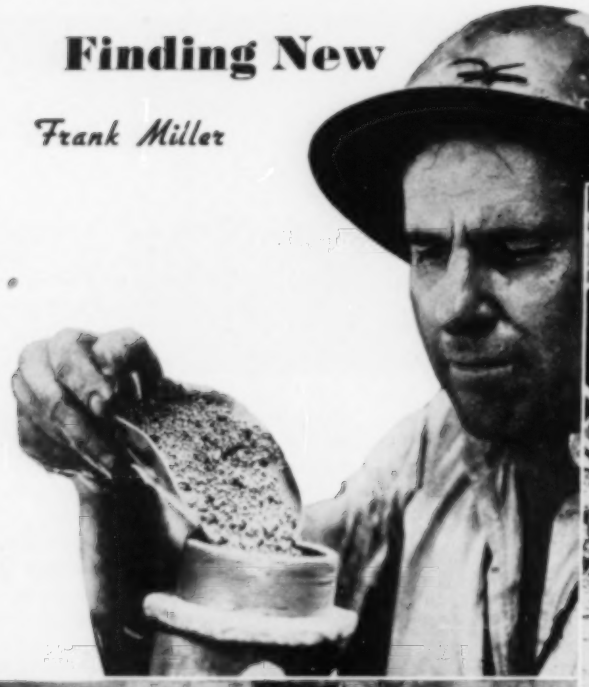
Completion of Broome County Airport will give the Tri-City area air-transport service surpassing that of all other cities of the state except New York. Transcontinental & Western Air Lines, Colonial Air Lines, and American Air Lines are the three major air carriers that have been granted permission to serve the field, while Robinson Air Lines will provide regional transportation.

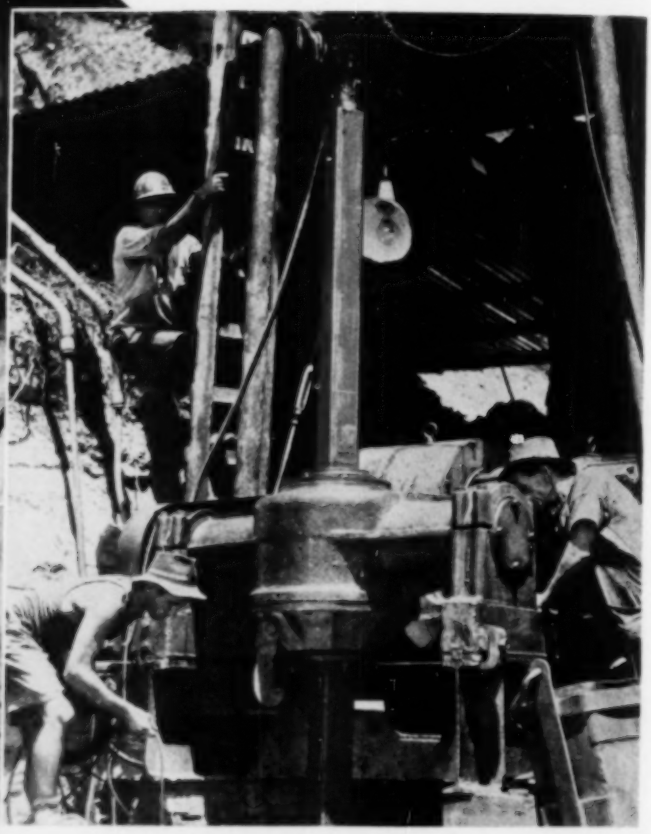
Appreciating that an airport is no better than the roads leading to it, the Broome County authorities are planning to make the field the focal point of three traffic arteries. The highway program will involve a cost estimated at $500,000 and will require several years for completion. It is to start at once with the improvement of one primary road.

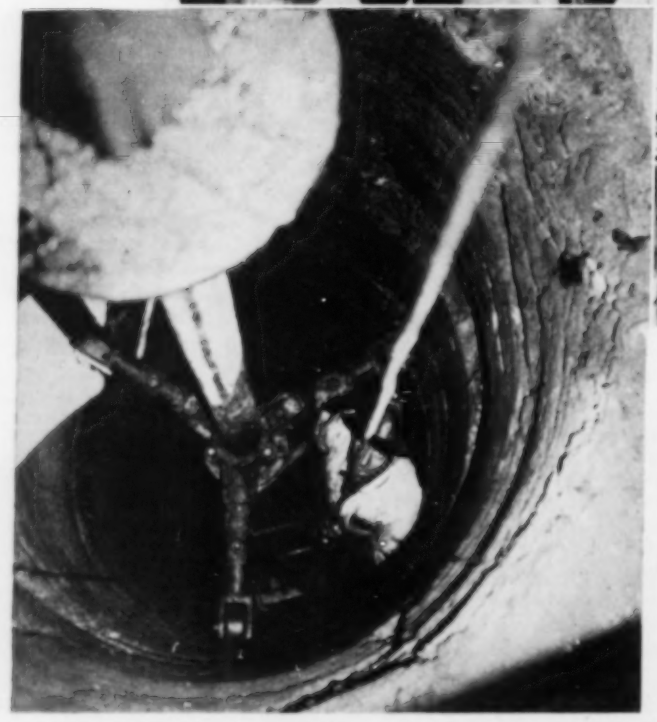
J. M. Nicolson is general superintendent for D. W. Winkelman Company on the Mount Ettrick Project. S. P. Carman, representing Seelye, Stevenson, & Value of New York City, is consulting engineer for Broome County.

# Finding New Uses for the Calyx Core Drill

*Frank Miller*







**EXPLORING DAM FOUNDATIONS**

Calyx core drills are used extensively for testing rock formations underlying dam sites for strength, soundness, and general suitability as a foundation material. At the Warragamba Dam site on the Nepean River, New South Wales, a total of 2570 feet of 48-inch-diameter holes was sunk in exploring the sandstone foundation rock. When completed, the dam will be a 340-foot-high gravity structure capable of impounding 450 million gallons of water. Shown above is one of the drills used there. The 5½-inch square spindle that turns the rods and bit can be seen extending through the driving head. Pictured at the upper left is a workman pouring chilled steel shot into the wash water flowing to the rotating bit. At the left is a view down one of the holes. The three arms extending from the drill rod to the side walls keep the rod centered in the hole. These centralizers are spaced at intervals of about 40 feet.

THE Calyx core drill, sometimes called shot drill, occupies a unique position in the rock-drilling field. It is used for boring large-diameter holes, work in which no other rotary tool can match it in first cost, performance, and economy of operation. Since its introduction into this country from Australia about half a century ago it has become standard equipment for special jobs in construction, mining, quarrying, and similar operations. In recent years, however, the scope of the Calyx drill has been broadened, and these new applications, together with improvements that make it possible to drill large-diameter holes of great depth, have widened the equipment's field of usefulness.

The most common form of Calyx drill is the drill-rod type in which the bit is rotated by a hollow rod driven by a motor and gearing located on the surface. The bit, made of mild steel rolled into cylindrical form, has several inclined slots cut in the lower edge. Chilled steel shot is fed into the hollow drill rod along with water and carried by the latter down the inside surfaces of the bit, through the slots, and under the cutting edge. There the shot is crushed by the weight of the bit. The particles become embedded in its soft metal edge and wear away the rock beneath by abrasive action as the bit rotates at speeds varying with its diameter. After passing through the slots, the circulating water rises on the outside of the bit, carrying the rock cuttings with it to the top of the bit where, because of a decrease in the velocity of the flow, they fall into a sludge receiver. Only enough water pressure is used to remove the cuttings without disturbing the heavier shot.

The Calyx drill is primarily a rock drill and as such is not intended for cut-

ting through overburden or formations which are softer than the bit itself. The abrasive action of the bit is impaired if the steel shot is not crushed between it and the material penetrated. Cutting speed therefore depends upon the type of rock drilled. With a 48-inch-diameter bit it is possible to cut limestone, for example, at the rate of 15-18 inches an hour; granite at 10-12 inches an hour. For any given rotational bit speed, the drilling speed in a particular material depends upon the rate at which shot is fed to the bit and upon the pressure exerted on the rock by the cutting edge.

When the bit has penetrated to a depth equal to its height, the core must be removed from the bit before further drilling can be done. Cores ranging up to 20 inches in diameter are released by introducing small pieces of gravel about the size of peas or beans into the wash water flowing to the rotating bit. These become wedged between the bit and the core, breaking off the latter and holding it securely so that it can be raised to the surface with the bit.

Cores that are 36 inches in diameter and larger are removed by an entirely different method and, if of solid rock, may be brought to the surface in one piece. The bit is first lifted out of the hole by means of the hoist with which each Calyx drill is equipped, and the excess water is withdrawn by a baler or by an air-driven sump pump. Next, a man is lowered into the shaft to drill a hole in the center of the core for the insertion of a split pin with an attached ring to which a cable is fastened. The core is then broken off at its base either by driving wedges along one side or by exploding a small charge of dynamite and, that accomplished, is raised by the hoist.

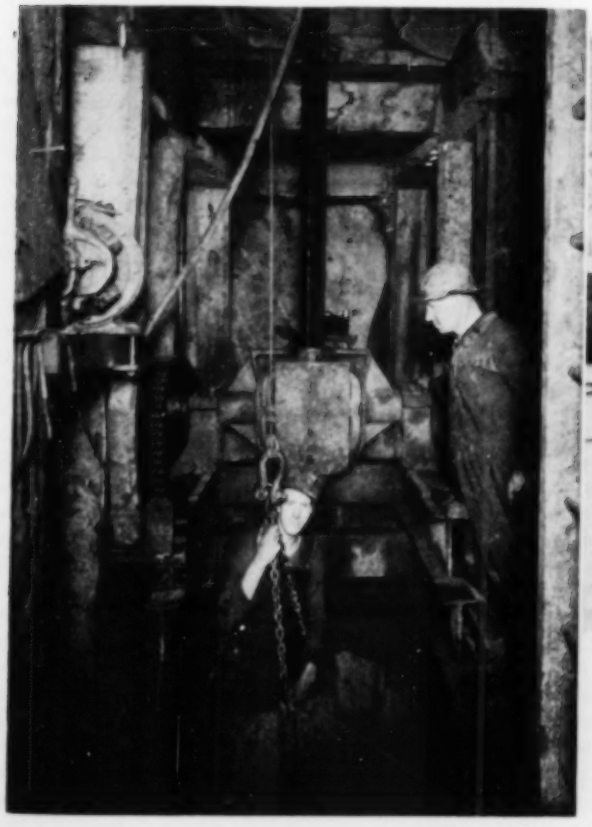
The work of extraction may also be done by a core lifter, a cylindrical device that slips over the core and grips it firmly so that it can be raised. If a core is broken, the main pieces are removed separately by cable slings and the bottom is mucked by hand into a bucket before the bit is again lowered and drilling resumed. A steel derrick is usually erected over the opening to facilitate handling the bit, drill rods, core lifter, baler, and other equipment.

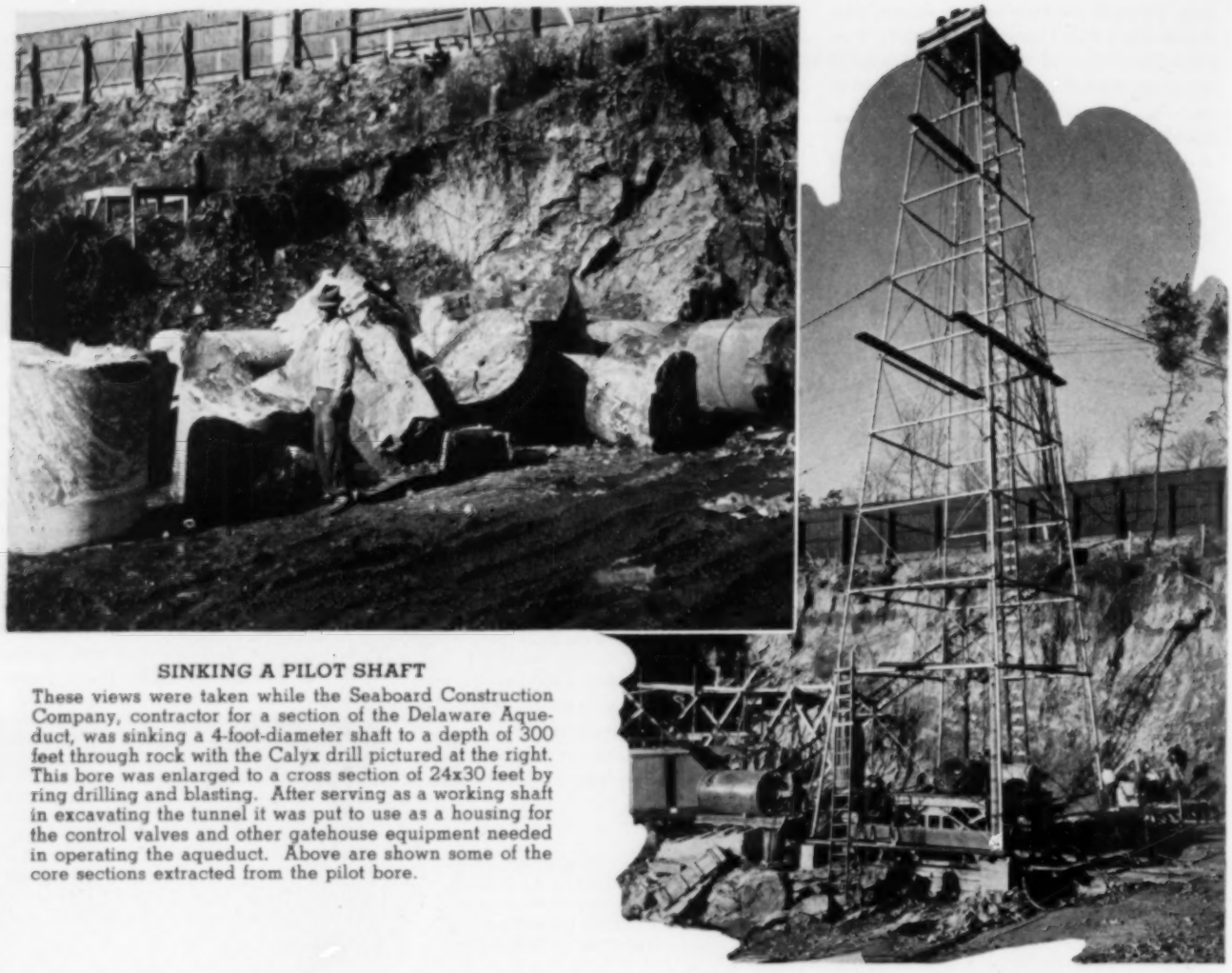
Calyx drills of the drill-rod type are designed to cut holes up to 48 inches in diameter to depths of 400-500 feet. They have been widely used for this purpose in the building of dams, where the weight of the massive structures and the immense sums of money involved necessitate taking every precaution to insure a firm foundation. Prior to the construction of Norris Dam, one of many erected by the Tennessee Valley Authority, knowledge of subsurface geologic formations was generally obtained by means of small coring drills. These, however, sometimes give unreliable information in the case of ground containing soft spots or other weaknesses because the small cores often disintegrate. Therefore, engineers at Norris Dam decided on a new method of underground exploration that called for the cutting of 36-inch-diameter holes with a Calyx core drill and lowering a man into the holes to study the formations in place. The initial results were so satisfactory that the procedure was adopted for Grand Coulee, Fort Peck, Bonneville, Shasta, Friant, and other western dams and is now standard procedure for structures of that type built under the supervision of the U. S. Bureau of Reclamation and the U. S. Army Engineers.

Also at Norris Dam, the Calyx drill served to check on the effectiveness of grouting that was injected into underlying formations to make them imper-

**VENTILATING MINE WORKINGS**

Pictured below, left, is a 36-inch Calyx core drill being used to sink a ventilating shaft between levels in a large underground mine. The frame carrying the driving head, motor, etc., has been moved back from the opening to permit a man to enter the hole in a bucket to remove bits of broken core. At the right the bit is shown as it is about to be lowered into the hole to resume drilling. A section of the core removed from the hole is seen at the bottom-right.





**SINKING A PILOT SHAFT**

These views were taken while the Seaboard Construction Company, contractor for a section of the Delaware Aqueduct, was sinking a 4-foot-diameter shaft to a depth of 300 feet through rock with the Calyx drill pictured at the right. This bore was enlarged to a cross section of 24x30 feet by ring drilling and blasting. After serving as a working shaft in excavating the tunnel it was put to use as a housing for the control valves and other gatehouse equipment needed in operating the aqueduct. Above are shown some of the core sections extracted from the pilot bore.

vious. On that job, a clay seam in the rock was washed out by jets of high-pressure water introduced through holes put down with wagon drills and filled to refusal with grout injected through the same openings. Next, more than 500 Calyx holes 5½ inches in diameter were drilled on 20-foot centers and a periscopic device used to peer into them to examine the grouting. Grouting was done through closely spaced holes of the same kind at other dams to stop leakage.

Calyx drills have been used extensively in foundation work for large buildings. In addition to cutting holes for the purpose of determining the character of the subsurface, they have played a part in the actual excavating. Many of New York City's skyscrapers rest on concrete piles that consist of sections of steel casing driven into soft ground and filled with concrete. Sometimes it was necessary to bore through large boulders that lay in the path of a pipe, and this work was done by Calyx drills. They have also served to cut shafts for the installation of elevator plungers, and the stage in Radio City in New York is raised and lowered by plungers traveling in Calyx boreholes.

Other industries have made considerable use of the Calyx drill. In the slate quarries of Pennsylvania, where the brittle nature of the material prohibits explosives in mining, it is utilized to put down holes for the tension posts of long wire saws that cut the beds of slate into blocks for processing. Because of its smooth cutting action, the drill does not damage the material; in fact, even the core removed from the drill hole is usable slate.

Highway departments of many states mount small Calyx drills on truck or trailer bodies to extract cores from newly completed roads. This is done in order to make sure that specifications have been met in regard to thickness, grade of construction materials, etc. These outfits are also used to raise sunken sections of concrete highways by cutting holes through them and injecting a soil-cement mixture under the slabs until they are restored to their former level, a procedure known as mud-jacking.

One of the more recent applications of the core drill is that of boring holes to serve underground mines as ventilating shafts or ore and waste passes. For operations of this type, the motor, gears, driving head, and hoist are grouped in a compact arrangement on a frame which is mounted on rail-car wheels so that the unit can be rolled back from the drill hole when removing or inserting tools. Motors, gears, and other moving parts of the model designed for underground work are completely enclosed to keep out dust, dirt, etc. Furthermore, it is built so that it can be dismantled and lowered, piece by piece, through the opening it has drilled, thus permitting its transportation below ground in spite of the restricted space.

Ventilation shafts put down by Calyx drills possess many advantages over those driven by conventional means. Because no explosives are used there is no shattering of the surrounding rock. Consequently, timbering is not needed, the walls standing entirely without support. This permits a greater flow of air than through an ordinary timbered shaft of equal cross-sectional area, for rough timbers offer an appreciable resistance to the passage of air. Furthermore, timbers in a ventilation shaft increase the hazard of fire in a mine. The same is true of ore or waste passages bored by the Calyx drill. Their smooth, untimbered walls present no obstacle to the material, so that it will seldom hang up and choke the passageways. In regard to the cost

of such boreholes, a shaft 36-48 inches in diameter can be sunk by a Calyx drill for about the same amount as by conventional methods.

A good example of Calyx holes drilled for ventilating purposes is found in a Montana copper mine. There a unit, powered by a 30-hp. motor, was set up underground to sink shafts during the driving of bottom levels. The ventilation of such workings during the development stage is usually a major problem, for the raises by which a level is connected to the upper workings and by which free passageway for air is provided are normally not driven until the level is completed or at least considerably advanced.

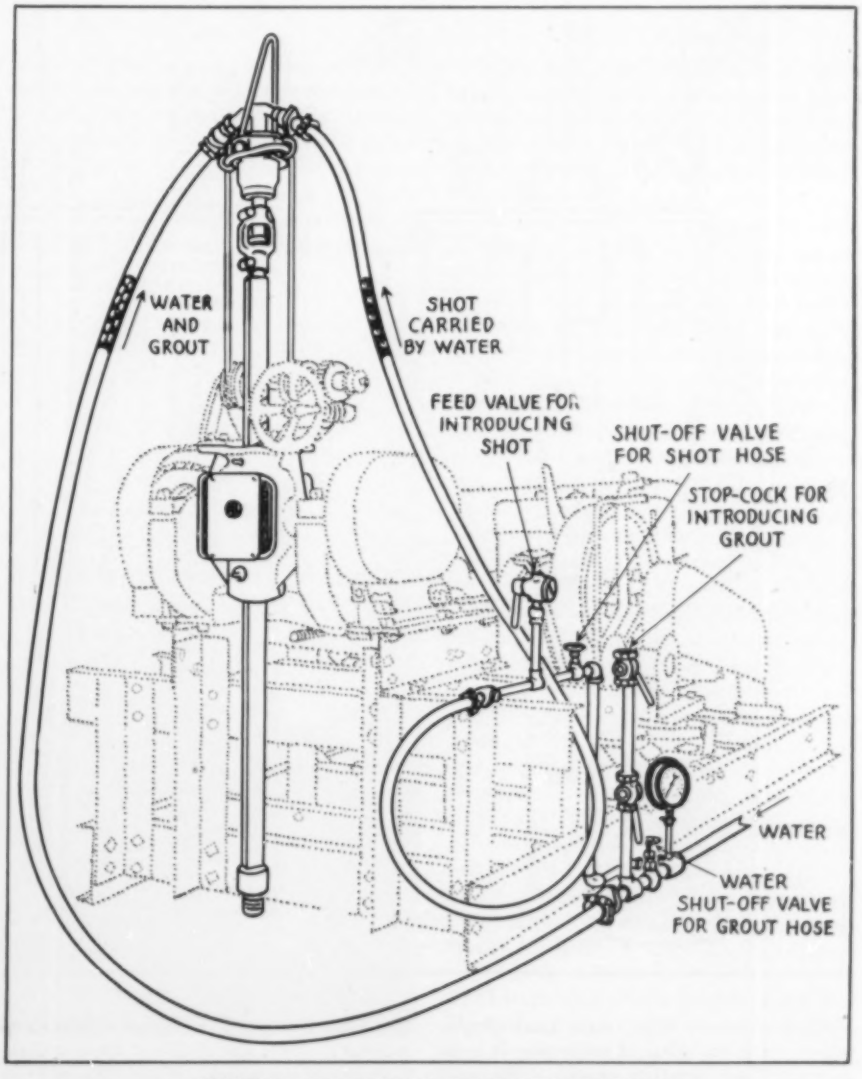
In the Montana mine, however, the difficulty was overcome by sinking 36-inch-diameter holes from an existing level to intersect one to be opened up directly under it, the work being carried out in advance of the actual excavating of the lower level. The first such opening was drilled at a distance of approximately 100 feet from the main shaft. It served as a return-air shaft and obviated the need of partitioning the main shaft into upcast and downcast passages. The second hole was drilled at a point about 1000 feet from the main shaft. When the men driving the bottom level reached this opening it became the return-air shaft by shifting the ventilating fan from the first hole, which was then used to carry pipes, electric cables, and communication lines between the two levels. The 36-inch return-air shaft is equipped to handle 20,000 cfm.

One of Arizona's largest underground copper producers cuts numerous Calyx holes to serve as fill holes for stopes where the outline of the ore body is definitely known. The mine is worked by the inclined cut-and-fill method, and holes 48 inches in diameter are sunk at intervals of 50 feet for filling stopes following cuts. Where irregular ore bodies lie at low angles, their upper extensions are filled by chuting waste through Calyx holes bored to meet the extensions. Another use found for the holes is as passageways or emergency exits, each being equipped for the purpose with steel-runged chain ladders.

A large copper mine in Montana has a system of handling waste that involves drilling 48-inch-diameter Calyx holes parallel to and at a distance of approximately 60 feet from the main shafts. These boreholes connect with stations at each level, and the material may be either drawn off at the stations or by-passed to levels below. The waste is carried to the top of the system by bottom-dump skips and distributed thence throughout the mine. This eliminates costly transfer by cars and is made possible only because of the availability of core drills, as the nature of the country rock does not permit blasting within 100 feet of the shaft. The same mine also uses such holes for ventilating purposes.

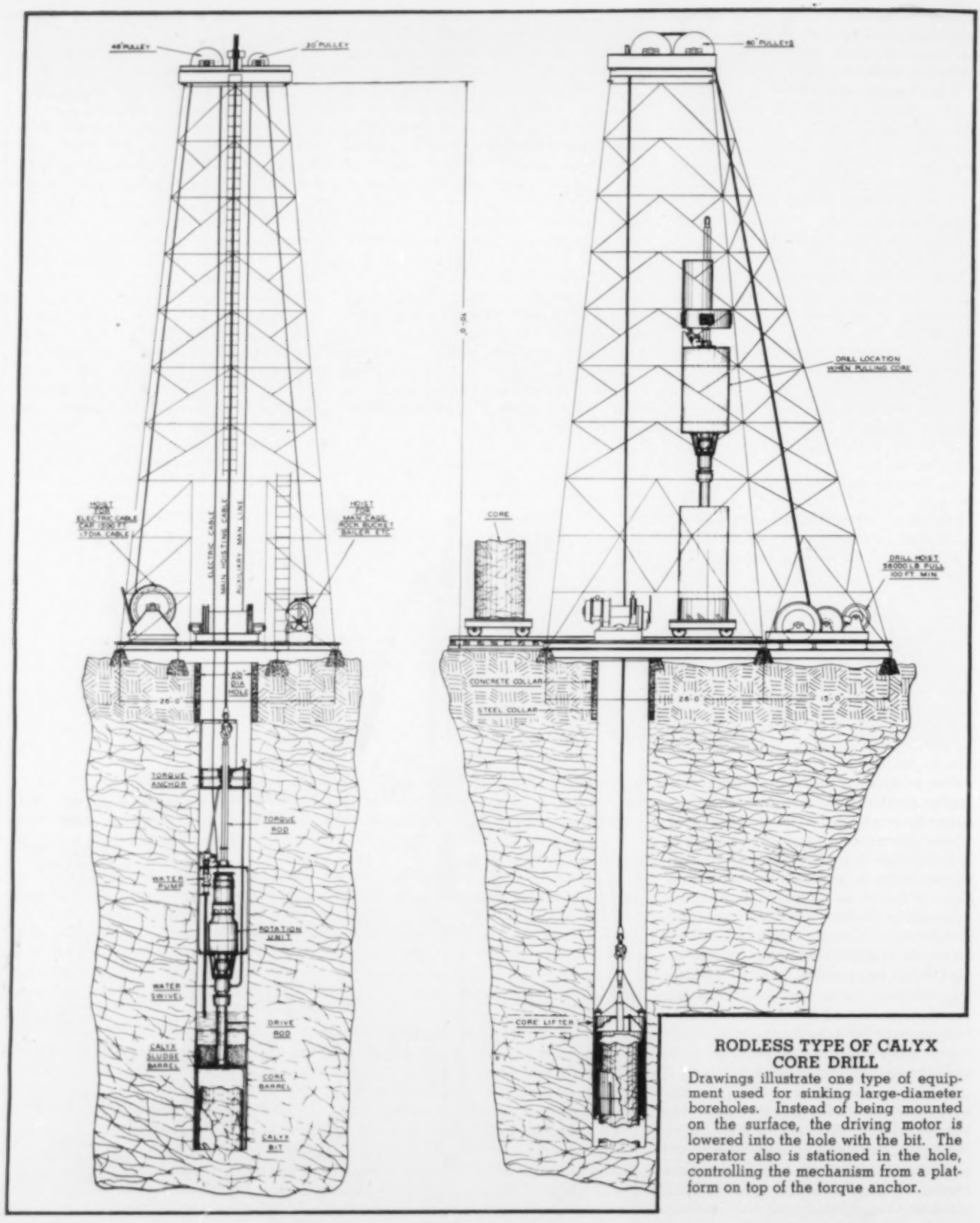
One application of the Calyx drill that seems to have a promising future is that of putting down pilot bores when sinking shafts between levels in a mine or from the surface. One copper producer has practiced this method with good results in deepening an auxiliary shaft. A 48-inch-diameter hole was first drilled from the bottom of the shaft to a level 300 feet below. The opening was then enlarged from the top down, all rounds being blasted into the hole, from which the broken rock was withdrawn by way of a chute dumping into cars on the level beneath. Besides obviating the disposal of muck by hoisting, the pilot bore maintained ventilation in the shaft so that smoke and gases could be quickly exhausted from the working area following shooting. The hole also provided drainage, eliminating the periodical removal of water from the shaft bottom.

In recent years, the number of holes of large diameter sunk from the surface to considerable depths has been on the increase. The mining industry has put down three, the first one on record being a 60-inch-diameter hole 1125 feet deep drilled at the Idaho-Maryland Mine in California for use as a service and ventilating shaft. Two boreholes each 66 inches in diameter were put down by Pickands, Mather & Company on the iron range of Minnesota and Wisconsin. One of them at the Zenith Mine is 1208 feet deep. It was equipped with a fan to serve as a ventilating shaft, handling some 50,000 cfm. of air. Later it was enlarged and converted into a 5-compartment, steel-supported, main hoisting shaft, the work being done by blasting rounds into the opening and pulling the muck from the bottom through a chute. The second hole was sunk at the Cary Mine to a depth of


WATER AND GROUT
SHOT CARRIED BY WATER
FEED VALVE FOR INTRODUCING SHOT
SHUT-OFF VALVE FOR SHOT HOSE
STOP-COCK FOR INTRODUCING GROUT
WATER
WATER SHUT-OFF VALVE FOR GROUT HOSE

**METHOD OF FEEDING SHOT AND GROUT**

Steel shot, which is crushed to form the cutting abrasive, is introduced into the wash water while the bit is doing its work. After a length of core has been bored, the flow of shot is shut off and grout is introduced to break off the section inside the bit.




**RODLESS TYPE OF CALYX CORE DRILL**

Drawings illustrate one type of equipment used for sinking large-diameter boreholes. Instead of being mounted on the surface, the driving motor is lowered into the hole with the bit. The operator also is stationed in the hole, controlling the mechanism from a platform on top of the torque anchor.

2587 feet, more than twice that of the other, with the idea of enlarging it into a 13x21-foot hoisting shaft. This was done, the operations being carried out in a manner similar to those at the Zenith.

The equipment that is used to sink the large-diameter boreholes differs considerably from the drill-rod type which, because of the weight of the rods and the power required to turn them, is not economical beyond depths of 400-500 feet. A rig was therefore developed in which the motor is closely coupled to the bit, making a single unit that is lowered into the hole by a cable. The operator does not remain on the surface but descends with the drill. Standing on a platform built atop the motor, he controls the latter, the pressure of the bit on the rock, the flow of wash water,

and the feed of steel shot to the bit. A torque device that expands against the sides of the opening prevents the motor from turning as the bit rotates.

Drills for holes 6 feet and more in diameter are powered by a 100-hp. motor, the motor capacity depending upon the size of the drill. With the rodless type of Calyx, all the power generated by the motor goes into turning the bit—none is needed to rotate drill rods. Therefore, the only thing that limits the depth to which a hole may be drilled is the capacity of the hoisting equipment on the job. Further, when utilized for sinking mine shafts, this type of Calyx makes it possible to effect considerable savings because the installation can be engineered in such a way that the permanent headframe and hoist house for the shaft can be erected first and used to raise and lower the drilling equipment.

In view of the performances of the Calyx drill and the improvements that have been made in equipment, methods, and drilling speed, the author envisions still larger rigs and wider fields of application. For instance, there is every possibility that the shaft of the future may be circular in form. A borehole 10 feet in diameter would be no more difficult to drill than one 6 feet in diameter, because the average cutting speed of the Calyx does not decrease materially with an increase in the size of the bit. Such a shaft, with a spiral staircase to serve as a manway and with a circular or square cage in the center, certainly would seem to have advantages over the conventional shaft. No timbering would be required, as the staircase around the sides would prevent soft spots in the walls from sloughing off and would be much safer than the customary ladder arrangement.

**TESTING CONCRETE HIGHWAYS**

A Class PT Calyx core drill taking samples from a newly completed roadway section. This unit, mounted on a trailer base, incorporates a 25-gallon tank that supplies the bit with wash water.

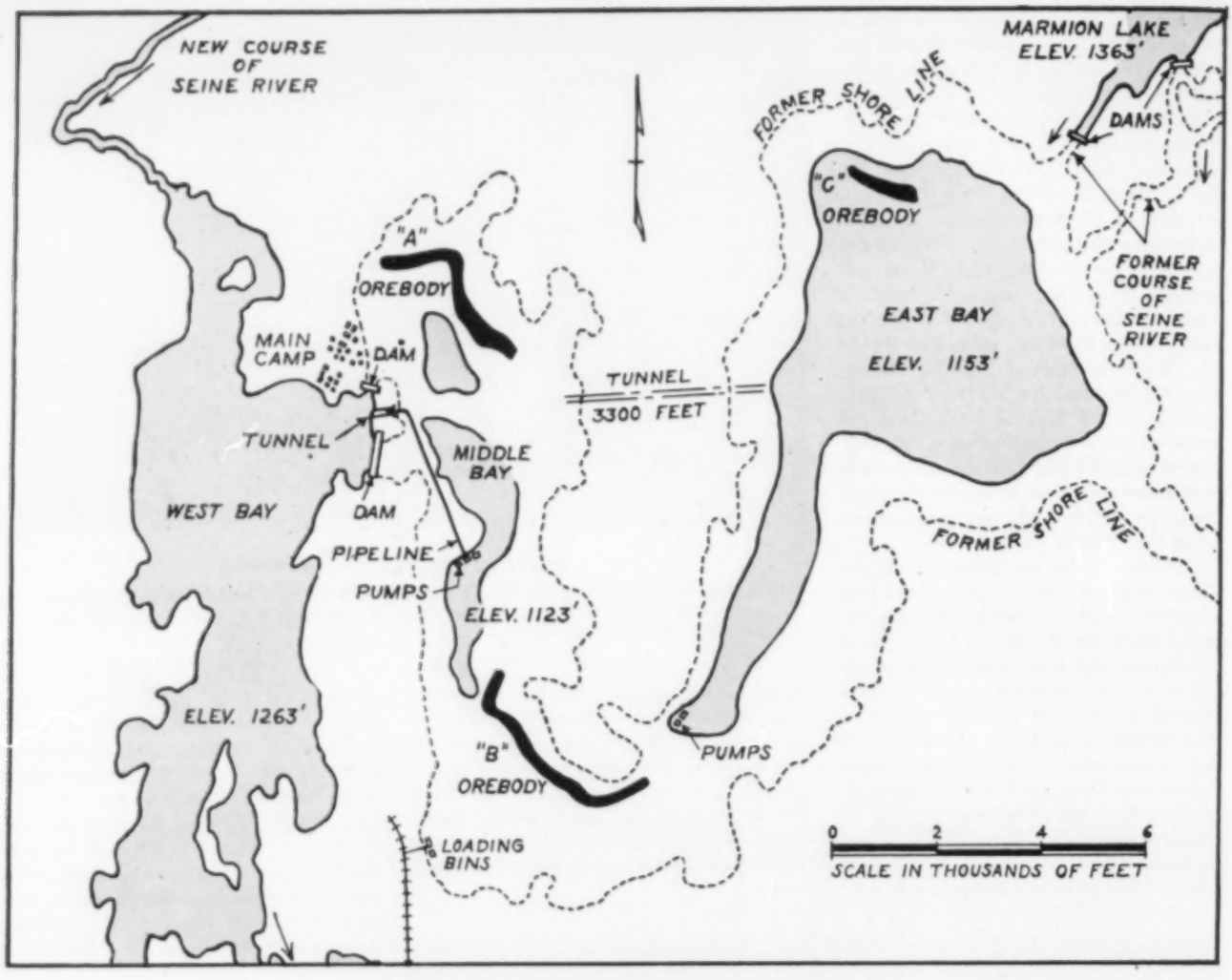
**STOPPING LEAKAGE UNDER DAM**

Water seeping under Hales Bar Dam on the Tennessee River was stopped by the Tennessee Valley Authority in a novel manner. A curtain of concrete was placed in the foundation rock just upstream from the dam by drilling rows of overlapping, 18-inch-diameter Calyx holes and filling them with concrete. Above is a view of six of the drills used in that work.

Other ways in which Calyx holes might be useful are in drawing off gases generated by burning thin, unworkable seams of coal *in situ* and in providing better ventilation in collieries. Vertical holes could be bored to draw off any gases that might be trapped in beds ahead of advancing workmen and at the same time establish ventilation as soon as they reached those areas. Another variation of the same idea, which has recently been patented, involves drilling a large hole from an underground level through coal-and-rock formations by first sinking a pilot hole for a rotating shaft and then, by a larger boring tool attached at the lower end of the shaft, drilling upward while disposing of the core on the bottom level.

The Calyx drill may, in future, find wide application in the search for mineral deposits. In addition to revealing information as to the character of the deposits penetrated, the boreholes would serve as ventilating or access shafts during the development and mining stages of the ore bodies. For example, should the extensive oil-shale deposits in our western states be exploited, as they undoubtedly will, the large-scale underground mining operations entailed would call for the use of power shovels, trucks, and other heavy equipment and would necessitate the delivery of large quantities of fresh air through suitably spaced ventilating shafts.

Though some of the potential applications of the Calyx drill may seem visionary to the layman, it is safe to predict that the equipment, because of the continual demand for better and more economical methods of shaft sinking, will play an increasingly bigger part in the rock-drilling field.




**GENERAL PLAN OF STEEP ROCK DEPOSITS**

The water in Middle Bay has been pumped out sufficiently to expose ore body "B" which is now being worked by the open-pit method. The top of "A" ore body is also below water level, but a thick layer of silt must be removed from it before mining can be started. As intermittent borings along the 6000-foot interval that separates "A" and "B" have indicated ore, these deposits may be connected at depth, making an extremely large ore body available. The surface of deposit "C" is still 375 feet underwater. The level of East Bay will be lowered 30 feet by diverting the water through the tunnel shown below the arrow. Several years of dredging would be required to expose ore body "C," but further exploration may prove that work to be economically warranted.

# Steep Rock Iron Mine

*W. M. Goodwin*

AN article in the April, 1943, issue of this publication described the early stages of the Steep Rock iron-ore development in northwestern Ontario, Canada. The finding of hematite boulders there as early as 1897 led to diamond drilling in 1938 that located underneath the bed of Steep Rock Lake three separate sizable ore bodies that are designated as "A," "B," and "C." An attempt to reach one of the deposits by means of a shaft and crosscut failed because of the influx of water, but it provided an opportunity to explore the ore occurrence at depth by drilling. The excavation of a new channel for the Seine River which flowed through the lake was completed at the end of 1943, the water of the lake and the silt on the bottom were pumped out by the spring of 1945 sufficiently to expose the "B" ore body, the highest of the three deposits, and in that year almost one-half million tons of ore was shipped mainly to furnaces in the United States.

Production from the "B" ore body is now established at the rate of a million tons a year, or somewhat better. Output is at present coming from an open pit 2000 feet long, which will be extended by 1000 feet or more. This pit is expected to yield ore at the current rate for some ten years. Before the pit reaches the limit of economy with increasing depth, an underground mine will be developed to yield a like annual tonnage. As the ore stands almost vertically and is proven to a considerable depth, the underground mine will last for many years.

Drilling has shown that "A" deposit is something more than double the size of "B" and that it similarly extends to a great depth. Though the water of the lake has been removed from above it, there remains a very large amount of silt in that part of the lake bottom, which is wide and long. Experience with "B" deposit has shown that the blanket of silt overlying the ore must be completely removed to permit mining the ore effectively.

The removal of this silt, estimated at 45 million cubic yards, will be a major operation. Fortunately it is known that the cost per yard will be extremely low. The fourteen big Ingersoll-Rand pumps that were used to pump out the lake and to remove the silt above "B" are not alone adequate for the job. What is projected is an operation similar to that in the Beauharnois Canal, on the St. Lawrence 30 miles west of Montreal, where a large suction dredge has dug a big power canal through clay at a phenomenally low cost per yard. Plans are being made to employ a somewhat similar dredge to complete the preparation of "A" deposit for open-pit mining. The estimated time of pumping is two years. When in full production, "A" deposit will furnish two million tons and more of ore a year. This will put Steep Rock in the top rank of North American iron mines.

While drilling has been concentrated on the "A" and "B" areas, enough prospecting has been done between them to show that there are at least scattered lenses of ore. From the geological evidence there is nothing to preclude the occurrence of ore continuously between the two, a distance of 6000 feet. With 4000 feet of ore indicated in "A" ore body and the south end open, and 4000 feet in "B" with both ends open, there is a distinct possibility that the whole length of Middle Bay, 2½ miles, may eventually become a single long, open pit. It will take a good deal more drilling to find out just how much of the ground between the two proven ore bodies is ore.

When the dredge has completed its job in Middle Bay there may be a still larger job for it in East Bay. The scattered drilling done around the north end of the bay has shown a widespread occurrence of the typical Steep Rock hematite, but the quantity available will remain uncertain until much more investigating is done. The indications, meantime, are that ore body "C" is still larger than "A." Its surface is some 375 feet below the present water level in East Bay, which, incidentally, will soon be lowered another 30 feet through the tunnel indicated on the accompanying plan of the deposits. To clean out East Bay would require several years of dredging, but further exploration may prove this to be justified.

The Steep Rock ore is of high grade, the shipments of 1,206,248 long tons in 1947 having had the following average analysis:

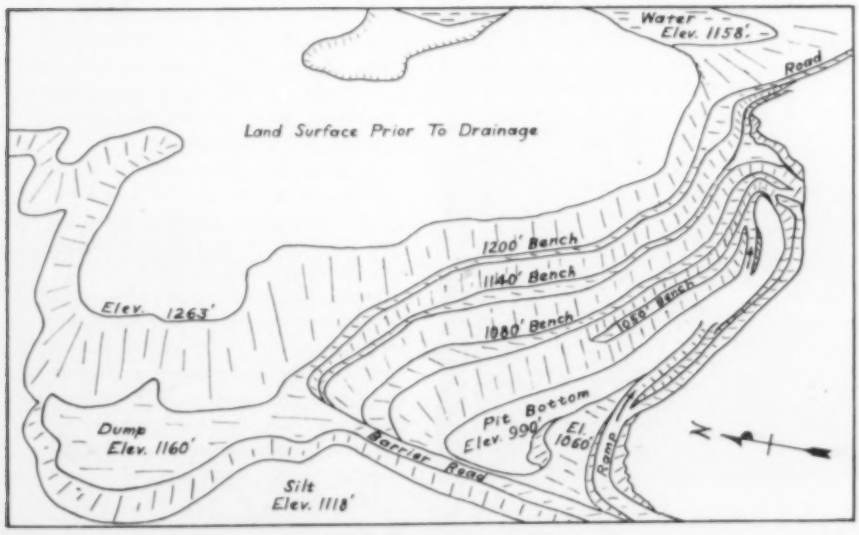
| | |
|---|---|
| Iron | 57.400% |
| Phosphorus | 0.028 |
| Sulphur | 0.041 |
| Silica | 7.530 |
| Manganese | 0.190 |
| Alumina | 1.570 |
| Moisture | 10.170 |
| Natural Iron | 51.560 |

The ore as dug from the pit is separated by screening and blending into the grades required. Last year's shipments of 61,155 long tons of Steep Rock open-hearth lump ore had the following average analysis:

| | |
|---|---|
| Iron | 59.170% |
| Phosphorus | 0.026 |
| Sulphur | 0.026 |
| Silica | 5.950 |
| Manganese | 0.160 |
| Alumina | 1.030 |
| Moisture | 5.920 |
| Natural Iron | 55.670 |

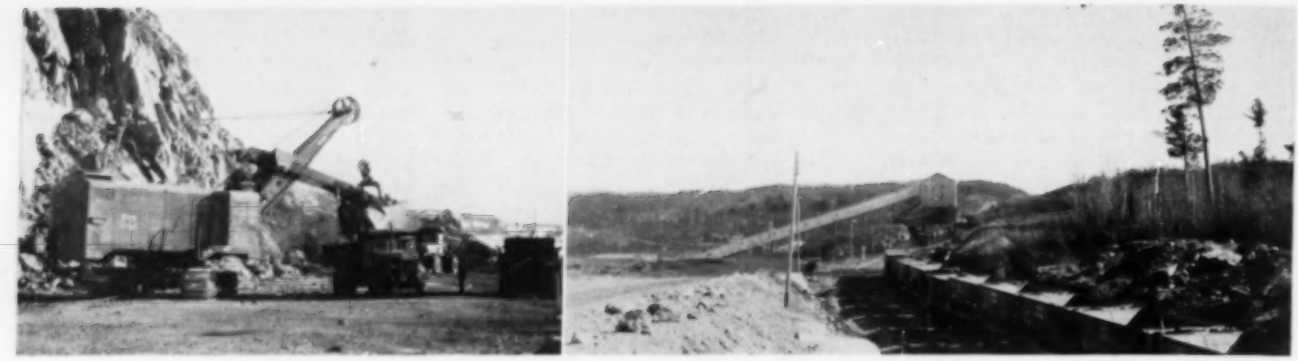
An important attribute of the ore shown by the analyses is the water of crystallization. The ore is actually nearer to the hydrated oxide of iron, goethite, than to hematite. It is the water of crystallization that makes the material so easy to reduce in the blast furnace and that has already made the Steep Rock lump ore a favorite with open-hearth operators. A 50-ton shipment that was treated last year in the Wiberg furnace at Soderfors, Sweden, proved it to be the most easily reduced ore ever handled there. The Wiberg furnace, which produces sponge iron, is capable of measuring accurately the relative reducibility of an ore, as the reaction is not complicated by the melting process, as in the blast furnace, and the exact carbon consumption is known because the coke is completely burned to carbon dioxide.

While the researches and studies of the relative reducibility of various iron ores are as yet far from complete, one can envision fairly safely the reason for the rapid reduction of the Steep Rock and other hydrated ores. The water of crystallization is held as a part of the molecule. As the water is driven off by the heat, the reducing gas comes into the intermolecular spaces to take its place, thus attacking the iron oxide in a most intimate way. In the case of hard




**OPEN PIT IN DEPOSIT "B" AND EXPLANATORY DRAWING**

At the top is an aerial view of "B" pit looking southeastward and showing a section of the partially drained East Bay of the lake in the background. The sketch identifies the various benches on which ore is being mined.



**SCENES IN "B" PIT**

Left, is a P&H 4-yard shovel loading ore into a Euclid 20-ton truck on the 990-foot bench, now the pit bottom. Before shipment, the ore is crushed and screened in the plant at the end of the railroad siding in the right-hand view.

hematite or magnetite or sinter, the reducing gas can react with the lumps of ore only on the outside surface, and thus can progress to the center by but slow degrees.

Steep Rock Mine draws its power supply from the lines of the Hydroelectric Commission of Ontario, the principal generating stations in this region being on the Nipigon River, 200 miles to the east. The ore is shipped over the Canadian National Railways to Port Arthur, where a modern ore dock was constructed by the Canadian Government in 1945. The present capacity is 30,000 tons, in 100 ore pockets. This is only half the size of the structure as designed, and the full 60,000-ton dock, capable of loading four 10,000-ton vessels simultaneously, will be required when both "A" and "B" deposits are in production. A corresponding increase in rolling stock and sidings will then also be needed.

The Steep Rock ore requires a minimum of treatment to make it ready for market. It is handled readily by electric shovels after being broken up by means of widely spaced churn-drill holes. The shovels at present are two P&H 4-yard and three Northwest 2½-yard machines. Twelve 20-ton Euclid trucks take the ore up to the crushing and screening plant alongside the railway siding. It all goes through the primary crusher, which reduces it to the 9-inch maximum size of the open-hearth lump ore. The crushed ore goes to screens which take out the lump ore, which bears the trade name of Steep Rock. Blending yields the single blast-furnace grade, called Seine River, being marketed this year.

Careful blending of the ore from the various parts of the long pit is done to meet the guaranteed shipping grades and at the same time to eliminate waste of merchantable ore. This requires the utmost skill and the constant coöperation of three men: the engineer in charge of the pit, the ore grader, and the shipper at the pier. Five of the 60-ton gondola cars are sampled as a unit immediately after they are loaded on the siding, and analyses are made without delay. These five-car units are then combined and blended in the ore pockets at the dock so as to give the required analysis. As might be expected, there are variations in the content of iron, silica, sulphur, and phosphorus in every carload; but, by means of the grading system employed, the analysis of the ore as transported in the ore boats is maintained consistently at the guaranteed figures.

The Steep Rock ores are high grade and sell at a high price. A small part of the output satisfies the needs of the blast furnaces of Ontario for such ores, so the bulk of the million tons a year is available for export to the United States. It might be noted in passing that the Helen Mine of Algoma Steel Corporation produces 600,000 tons a year of high-grade, fast-reducing sinter, half of which meets the need of Algoma's own furnaces at Sault Ste. Marie, Ontario, leaving the other half for export. Thus the two iron mines of Ontario provide at present 1¼ million tons of high-grade ore for furnaces in the United States, and in exchange the Canadian furnaces draw a somewhat larger tonnage of lower-grade ores from the American iron ranges.

While the present million tons or so from Steep Rock is small in comparison with the annual total of 60 to 80 million tons from the Lake Superior region, its importance is proportionately much greater. Of the total tonnage of Lake ores, only a small part is high in grade. As the high-grade ore supply of the open-pit mines is diminishing rapidly, it is important that it be supplemented to as great an extent as possible from mines in Canada. Steep Rock is providing a significant part of this supplementary tonnage of high-grade ore.

To sum up: Steep Rock now has an established production of a million tons a year, all high in grade. When the second ore body is in full production this will be stepped up to three million tons. If present indications of ore between the two proven deposits turn out favorably, we may see a pit that will be among the largest in the Lake Superior region. Beyond this, in another bay of the lake, there are indications of another deposit, but the information at present is too meager to say what it may amount to.

Meanwhile, it is a great satisfaction to the people of Canada that they are at last able to contribute their share to the iron-ore supply of this continent.

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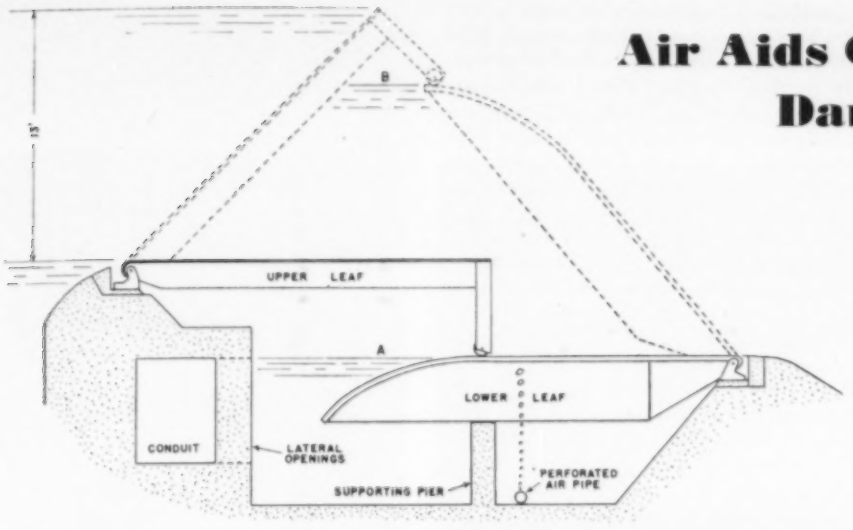
**ORE DOCK AT PORT ARTHUR**

Ore is shipped by rail to Lake Superior, where it is loaded into boats bound for United States steel mills. The dock used has 100 pockets, each of which holds 300 tons. Ultimately it will be double this size, and when ore body "A" starts producing it will be called upon to handle three million tons a year. It will then be able to load simultaneously four vessels such as the one shown.




# Air Aids Operation of Dam Spillway Gates

*Abraham Streiff*

**Modern Version of Old Bear-trap River Weir Controls Overflow of Possum Kingdom Dam.**

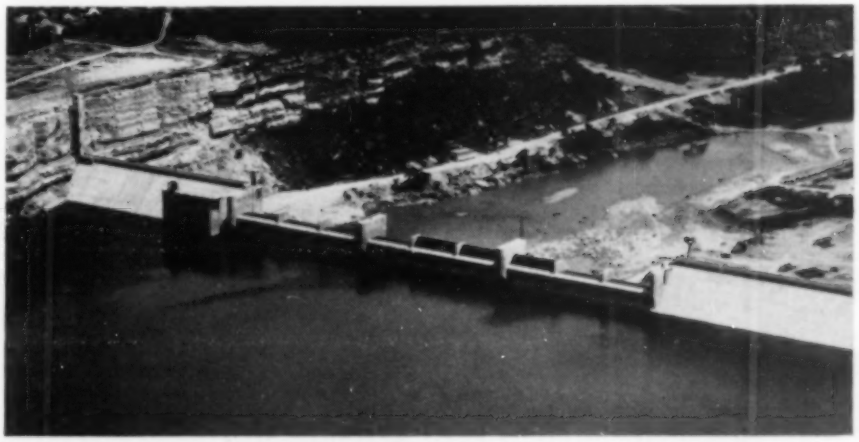
AN INTERESTING feature of the Possum Kingdom Dam in Texas are the spillway gates, which differ from conventional types in that they are designed to operate by compressed air. The dam is located on the Brazos River near the town of Mineral Wells and is the first one built of a series of thirteen planned under a multiple-purpose development project sponsored by the Brazos River Conservation and Reclamation District. This Authority was created in 1929 by the Legislature of Texas as a result of 30 years' effort by a number of public-spirited citizens of the Lone Star State intent upon conserving and harnessing the resources of the Brazos watershed.

In the arid and semiarid Southwest the water supply is, generally, markedly deficient, with storm floods at intervals that ravage the uplands and inundate the lower valleys for miles beyond a river's channel. To combat damage and to impound the floodwaters for use during dry periods, the Brazos Project was initiated by the construction of the Possum Kingdom Dam and reservoir. At normal pond level (Elevation 1000) the storage capacity is 757,000 acre-feet, and at 10 feet surcharge it totals 990,000 acre-feet.

The structure is situated at a scenic bend of the Brazos where one bank is a sheer rock bluff 200 feet high and the opposite shore is a sloping, wooded hillside. The foundation is composed of Pennsylvanian formations of limestone, sandstone, and shale. The upper strata of hard Merriman limestone rest on gray calcareous sandstone and compact, hard, so-called Wolf Mountain shale. The latter bed is of great thickness and forms the foundation for most of the dam. The maximum load imposed on this shale is only 5½ tons per square foot; the sliding factor for the spillway section is 46 percent.

No particular foundation problem was encountered, and care was taken to prevent drying out of the shale prior to pouring concrete by quickly applying a 6-inch mat of concrete. Excavating involved the removal of 150,000 cubic yards of rock and 350,000 cubic yards of earth. The principal structural materials required were 325,000 cubic yards of concrete and 7000 tons of reinforcing steel.

Possum Kingdom Dam is of the Ambursen reinforced-concrete buttress type and has an over-all length of 2740 feet. It consists of a powerhouse section 326 feet long, including the north bulkhead; the spillway, 707 feet; the south bulkhead, 600 feet; and of a 1107-foot earth dike with a concrete core wall. The buttresses are spaced on 40-foot centers and have a maximum thickness of 10 feet, diminishing toward the crest. The deck slope upstream is 10 on 8; downstream, 10 on 5.7. The deck thickness varies from 9 to 5 feet on the spillway and less



**HOW GATES WORK**

In the sketch, the solid lines show a gate when down and the dotted outline indicates its position when fully raised. Early, light-weight gates of this type were operated solely by headwater pressure, water being admitted under the leaves to push them up. The higher the upstream head, the higher the gates were lifted. However, the differential pressure is not sufficient to elevate the all-steel structures at Possum Kingdom Dam, so compressed air is provided to assist in the operation. As the reservoir level rises above the spillway crest, water is admitted under each gate through conduits having lateral openings. When the internal water level reaches the line A, compressed air is discharged through the perforated pipe and enters the lower leaf, which, being open at the bottom and closed at the top, is, in effect, a caisson. The air increases the buoyancy of the gate and, as more water is admitted, it rises, the upper leaf sliding over the cam-shaped upper surface of the lower leaf. If the pond level rises to the full 13-foot height of the closed gate, the internal water level will be at line B. As the upstream reservoir level drops, the water within the gate can be discharged on the downstream side to lower the gate. By pumping water under the gate and turning on the air pressure, the structure can be elevated even though there is no upstream head. It can then be locked and drained for purposes of inspection, painting, etc. The downstream aerial view of the dam shows the spillway section with three of the nine gates raised.

on the bulkheads. The height from the lowest buttress footing (Elevation 834.5) to the top of the spillway gates is 165.5 feet and to the top of the bulkheads, 189.5 feet. At normal pond level, the head on the turbines is 130 feet.

The spillway is of novel design and therefore of particular interest. Its discharge capacity is such as to take care of the flood flow from a drainage area of 20,000 square miles, of which 7000 is considered arid and noncontributing. The recorded peak flow is 165,000 second-feet, and the estimated maximum is 325,000 second-feet. The structure has nine gates separated by six low piers and two regulating piers. To provide against possible floods of exceptional volume, there is a 24-foot freeboard from the top of the gates to the crest of the spillway. Because of the great surcharge, the use of lifting gates with overhead structures was not desirable. Instead, disappearing gates were selected. When down, these leave a clear opening, except for the low separating and regulating piers between the individual gates.

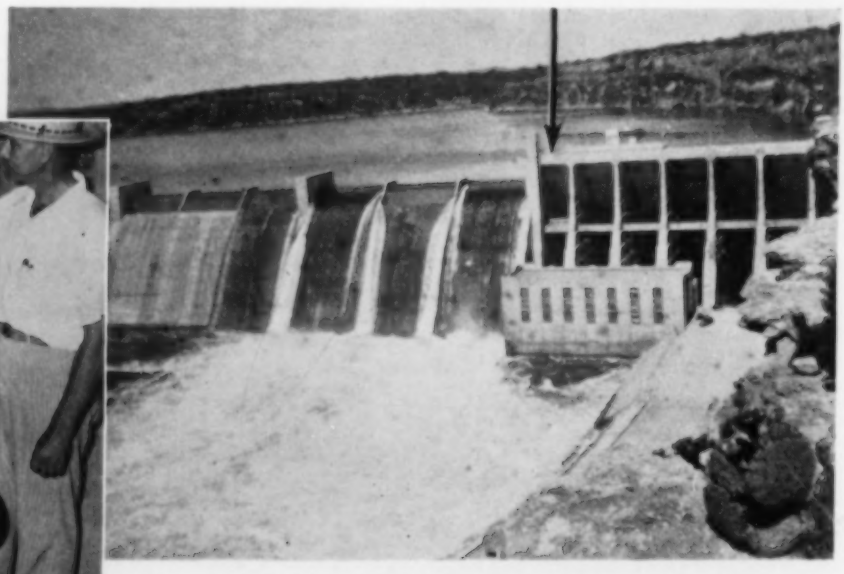
The principal forms of disappearing gates are the drum and the bear-trap, of which there are numerous variations. The gates of the Possum Kingdom spillway are an improvement upon the bear-trap type. The basic principle of the design is that use is made of the difference in water pressure above and below the gate for its manipulation. To close the gate, headwater pressure is admitted under it to raise the leaves; to lower it, the water under the leaves is drained into the tailrace.

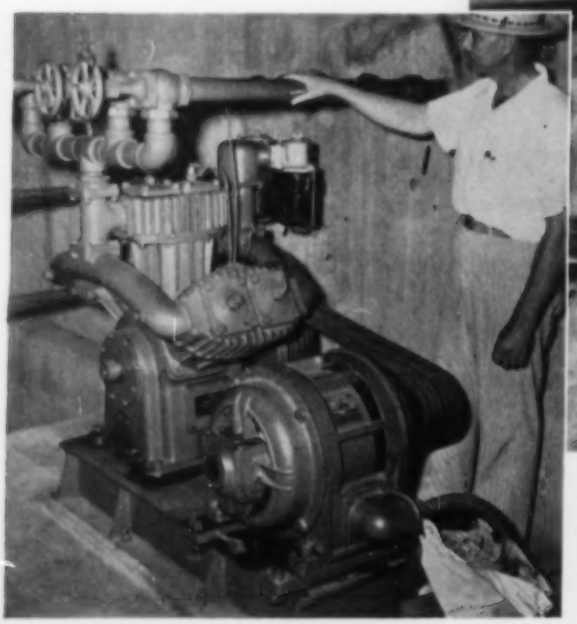
The prototype of the bear-trap was built by the Dutch hydraulician Donker at Gouda, Schiedam, and Alewein in 1770. It was re-created independently in 1818 by Josiah White and Erskine Hazard, who pioneered in water transportation of anthracite coal in the Lehigh Valley, and must be regarded as a typical American design. It was used extensively in this country, where existing examples are to be found well-nigh exclusively. The name is said to have been coined by a workman who, questioned by curious onlookers, told them that he was making a bear trap.

By 1819 there were already twelve bear-trap weirs in the Lehigh River. Their application spread rapidly even to France, where a "Porte Américaine" was built in the 70's in the weir of Neuville-au-pont-sur-Marne. This weir was not properly proportioned and brought the bear-trap into temporary disrepute. In a report published the same year, the French engineer and harbor expert Malézieux stated that the gate design had been discarded, and the well-known French navigation authority Lagrené said that the bear-trap was ingenious but not practical.

However, in 1882 Ashbel Welch, president of the American Society of Civil Engineers, renewed interest in the type for regulating the depth of water for inland navigation. The U. S. Engineer Corps and others then constructed many bear-traps of large dimensions for the control of the Ohio, Mississippi, Chippewa, Allegheny, and many other streams. The original White design was modified and improved by such notable engineers as Dubois, Parker, Girard, Brunot, Lang, Carro, Chittenden, Marshall, and a number of others. Beaver Dam No. 6 on the Ohio River, reared in 1904, has bear-trap gates 120 feet long by 13.2 feet high, and the late Prof. Gardner S. Williams built several of them into hydroelectric stations on the Huron River.

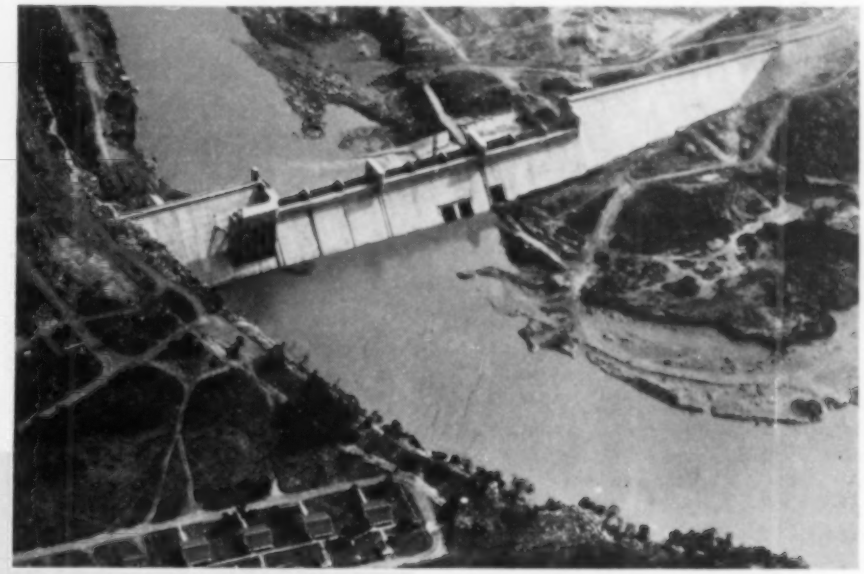
The next advance in bear-trap weirs was made by two Swiss engineers, Huber and Lutz. They redesigned the gate and obtained a much lighter structure by a skillful distribution of the reactive forces. The Huber gate, christened "roof-weir" by the originator, was so light and low in cost that it found its way into not only European but also American dams.

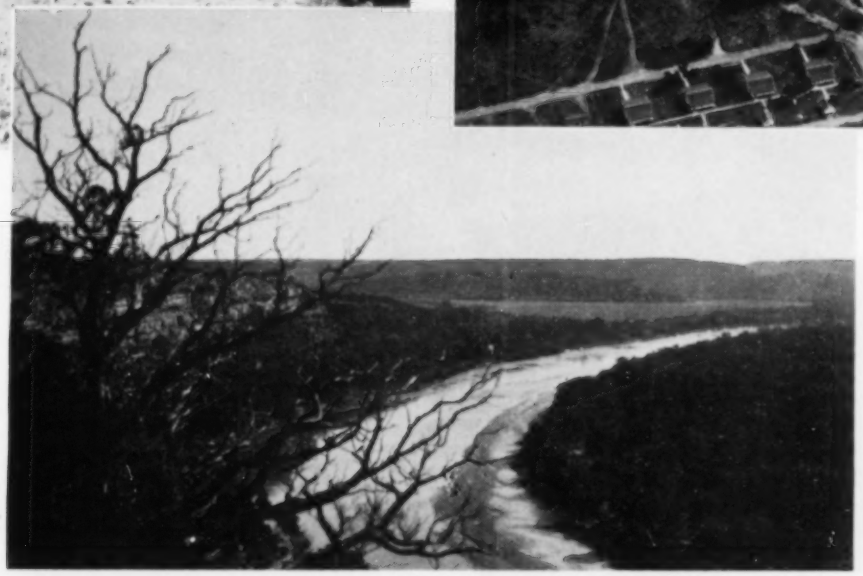




**COMPRESSOR INSTALLATION**

The comparatively small volume of air required to assist in closing the gates is supplied by the Ingersoll-Rand, air-cooled, motor-driven compressor shown at the left. It produces 300 cfm. at 25 psi. pressure. It is located in the pier adjacent to the spillway section, as indicated by the arrow in the picture above.





**VIEWS OF DAM**

Possum Kingdom Dam is on the Brazos River at a point near Mineral Wells in Palo Pinto County, Tex. It has an extreme height of 189.5 feet above the foundation rock and its power plant operates under a maximum head of 130 feet. These pictures show the site before construction began (bottom) and the dam during the concrete-pouring stage (left) and shortly before filling of the reservoir (below).

Fifteen such weirs, 98x12 feet and 78x12 feet, were incorporated in six dams on the Guadalupe River in Texas by the Fargo Engineering Company because the type was especially well adapted to cope with the great floods which occur in the Balcones fault region of that state.

For higher structures, the Huber gate was not suitable without further modification. So that its hydraulic balance could be maintained in all positions, it was given a timber facing in order to make it as light as possible. On high dams, where the timber facing is less accessible and would require too much upkeep, an all-steel gate is preferable. But this influences the hydraulic balance. When placed on top of such a structure, the water level could be considerably below the crest, necessitating special arrangements for gate control in all eventualities.

The roof-weir, when laid down, can be raised only after the water has been allowed to rise and spill about a foot deep over the top of the gate. This is not permissible in a dam with a 20,000-acre storage reservoir where such spillage might, depending upon the inflow, continue for months before the gate could be lifted. This would cause a great loss of water. Also, when spilling with a full head on the gate, the differential pressure would not be sufficient to raise the steel structure when completely down. In the old bear-trap of Neuville-au-pont-sur-Marne this was remedied by placing another Thénard flashboard, 2 feet in height, upstream. But that was not a practical solution, and on the Possum Kingdom spillway the writer applied compressed air.

For that purpose, the lower leaf of each of the nine gates was provided on the downstream side with plate-girder end frames and a plate-steel diaphragm. In down position, the lower leaf is now a caisson open at the bottom. An air line was laid on the concrete base slab under the gates, and an appropriate distribution system, with manifolds and regulating valves for the admission of air to the gates, was installed. Compressed air for the system is supplied by an Ingersoll-Rand, motor-driven, air-cooled unit having a capacity of 300 cubic feet of free air per minute at 25 pounds pressure.

When air enters the caissons, the gates immediately become buoyant and start to rise—in short, they are under complete control at all times and no water is spilled unless desired. Very little air power is required because the caissons are airtight. Under circumstances, a gate may have to be raised to full height when the water level is below the sill. This contingency has been provided for by the installation of a centrifugal pump with a capacity of 5500 gpm. This unit can be made to function like a hydraulic jack by pumping water under the gate. The caisson immediately floats the gate, and continued pumping raises it until it is closed—the position in which it can be locked and drained for inspection, painting, etc.

The gates designed for the Possum Kingdom spillway are lighter and therefore less costly than other forms of disappearing gates. Furthermore, through the introduction of caissons operated by compressed air they have been adapted for use on high overflow spillways for large-area reservoirs. The total cost of the project, exclusive of 20,640 acres of flowage land, was $5,800,000. The dam was designed by the Ambursen Engineering Company and built under its supervision by Lytle & Johnson, general contractors. Erection of the generating machinery was done under force account by the Brazos District.

# *Producing*
# BALLAST FOR THE UNION PACIFIC
## *at Sherman Hill*

*L. A. Luther*

THE Irish seem to hold an all-time record in laying rail. Gen. Jack Casement of the Union Pacific Railroad relied on them, and the competing Central Pacific, with several thousand Chinamen on the payroll, is reported to have fallen back on Irish luck and brawn to win a $10,000 bet that its forces couldn't build 10 miles of track in a day. A locomotive ran over the rails in forty minutes, proving it to be "good" by then-existing standards. However, a look at the track Casement and his Central Pacific competitors built in those days—even when not racing for transcontinental laurels—would give a present-day railroad passenger the creeps. The rail was light, about 56 pounds to the yard, and rested directly on unseasoned and often crudely hewn softwood ties.

The ballast was native soil, ridged up between the rails to give stability and shed rain. Many of the native materials used melted away like sugar under the washing of freshets, puddled to mud-pie consistency under ties, and, in the bitter Wyoming winters, swelled like salt-rising dough to heave the rails out of

### QUARRY OPERATIONS

Muck blasted down into coyote holes driven into the quarry face is moved out by a scraper drawn by a cable powered by an Ingersoll-Rand 2-drum, air-operated Utility hoist mounted on the rear of a truck. The hoist is also used for other hauling jobs such as that illustrated at the top, where it is about to pull a stone boat loaded with TNT into one of the holes. After a series of coyote holes has been put in and tees at their inner ends have been loaded with explosive, the passages are backfilled with quarry waste. This is conveyed through a pipe line with compressed air. The center view shows a clamshell bucket loading material into the hopper of the Pressweld concrete placement machine that is used for this pneumatic "shooting." The picture gives an idea of the height of the quarry face. A P&H 5-cubic-yard electric shovel is seen at the left loading quarry rock into a Euclid 10-ton truck for transportation to the crushing plant.

**CRUSHING PLANT**

Quarried rock is reduced to ballast size by repeated crushing and screening operations. A part of the plant, with stockpiles and tipples for loading the stone into cars, is shown here.

line and surface. Finding a ballast material that could be produced economically in that unmechanized era was a difficult problem for the young and then not too affluent U.P. However, in negotiating the first and highest mountain barrier on the 50-mile stretch between Cheyenne and Laramie, it was discovered that the track crossed a hill of first-class ballast material that extended right to the surface.

Its outcrop at many points seems to be ordinary granite, and automobile tourists still stop to photograph storm-tortured conifers that appear to have their roots in solid rock. Having weathered and disintegrated through the centuries, the rock is relatively friable, breaking up freely into small cubes of reddish color. This material became nationally known among railway people as Union Pacific's "Sherman Hill Ballast," and many thousands of carloads of it were placed in track in Wyoming, Nebraska, Colorado, and Kansas.

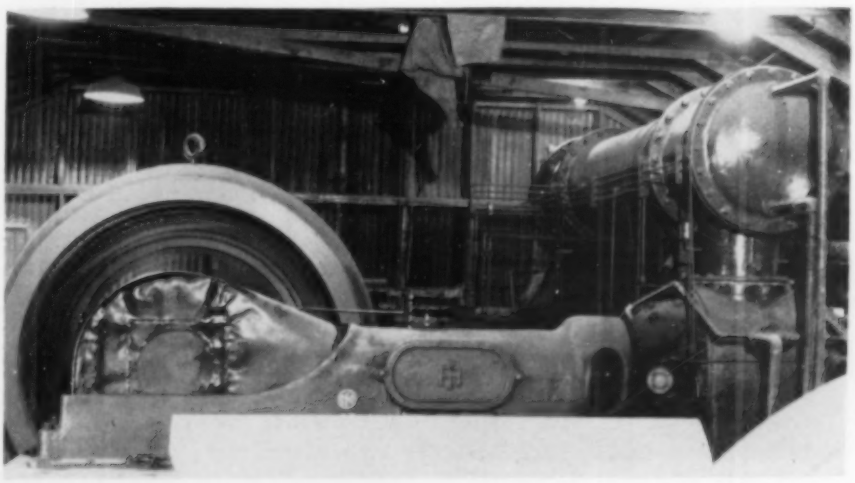
In recent years, the rock was loosened up for loading with power shovels by drilling deep holes by means of Jackhamers. Large groups of holes were sprung, loaded heavily, and fired in unison. Sherman Hill Ballast was cheap, provided good drainage, was an easy material with which to maintain good track surface and make tie renewals, and gave the track quiet, slightly cushiony riding qualities.

As locomotives grew many times heavier and belched out cinders in great volumes to foul ballast, and as trains became correspondingly longer and heavier, this brittle material suffered from mechanical wear and was unstable in the cyclonic drafts created by 90-mile-an-hour streamliners. Always a pioneer in using heavy power to move heavy trains on fast-freight schedules and in combining speed with comfort in passenger service, the U. P. made extensive explorations and tests of various ballast sources. It produced considerable material from crushed boulders in a glacial moraine near Evanston, Wyo. Then the investigations revealed that the big hill west of Cheyenne was literally as rich in ballast as the "Big Rock Candy Mountain" of the range-rider song is in "rock candy." A rugged covert for sniping Indians during construction days, and a rendezvous for blizzards that still make winter railroading a duel with the elements, it gradually has made amends for the hardships it has imposed.

Core drilling disclosed a lifetime supply of excellent hard granite at Granite Canyon, some 20 miles west of the Wyoming capital and 10 miles east of the Sherman Hill pits at Buford. In early 1945, Morrison-Knudsen Company, Inc., began operating the world's largest crushing plant devoted exclusively to producing railway ballast. It has a capacity of 80 carloads a day, and two million cubic yards has thus far been shipped to points in the four-state area previously served by the Buford pits. As much as 71,000 tons has been stockpiled over the conveyor-equipped tunnel which delivers to twin car-loading tipples.

In opening the quarry, drilling was done with eight FM-2 wagon drills mounting X-71 drifter drills. Some experimenting in production drilling was done with churn drills, but the present practice is to use 3x4-foot coyote holes. Spacing and length of the coyotes is calculated with relation to height of face. Those in a typical group of twelve range in length from 40 to 70 feet and have 15-foot tees at their inner ends. The latter are charged with an aggregate of 131,000 pounds of Government surplus TNT, which is fired simultaneously and shatters 80,000 cubic yards neat, producing approximately 300,000 cubic yards of broken rock.

Drilling inside the coyote holes is done with J-50 Jackhamers. Muck is removed by a scraper drawn by an ingeniously truck-mounted Ingersoll-Rand HNN-1J double-drum, Utility air host. There are two of these units and they also pull loads of explosive into the holes. Each hoist has a cable pull of 2000 pounds when supplied with air at 80 psi. pressure and a cable speed of up to 130 feet per minute. Two No. 25 sump pumps



**AIR COMPRESSOR**

Compressed air for drilling, placing backfill in coyote holes, operating gates in the crushing plant, and for other purposes is furnished by three Ingersoll-Rand compressors, of which the synchronous motor-driven PRE-2 machine shown here is the largest.

**SHERMAN HILL, TRAIN AND MONUMENT**

These pictures show a Union Pacific 4000 Series Mallet locomotive, reputedly the largest in existence, approaching Sherman Hill summit eastbound with a train of Wyoming coal, and a 60-foot granite monument on top of the pass inscribed to Oakes and Oliver Ames, early U.P. financiers and officers. The line now crosses the pass at a lower elevation, having been relocated early in the company's history.

are used for emergency dewatering service.

Some 3700 cfm. of sea-level compressor capacity is represented by a 28&17½x 21-inch synchronous motor-driven PRE-2, a belted 17&10x14 XCB, and a Model 75 air-cooled, V-belt-driven Motorcompressor. The first-mentioned unit supplies air for normal operation, and the Model 75, housed separately near the loading tipples, furnishes air for operating loading gates when the plant is closed down. After powder has been placed in the tees at the inner ends of the coyote holes, the remainder of each passage is filled with quarry waste to act as stemming. As the material is "shot" in with compressed air, the old XCB compressor is operated to meet the additional demand for air whenever both drilling and backfilling are in progress. The quarry waste is hauled to the portal of a coyote hole in Euclid trucks and unloaded by a crane-operated ½-cubic-yard clamshell bucket into the hopper of a 1-yard Pressweld concrete placement machine. From the latter it is delivered into the hole through piping that is gradually shortened as filling progresses. The adoption of this pneumatic method has made it possible to backfill three holes in a shift, whereas formerly three shifts were sometimes required to backfill one hole when the material was scraped in and then placed by hand shoveling. Also, the material is stowed more compactly and, consequently, in greater volume.

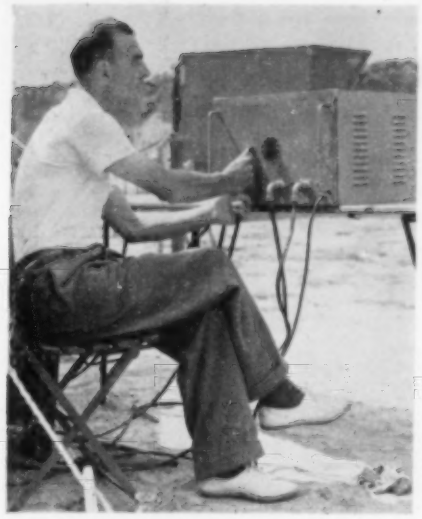
**ROOTED IN ROCK**

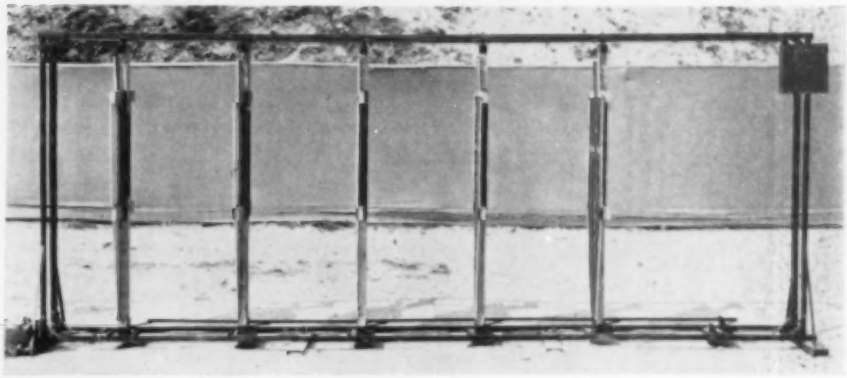
A pine tree growing out of a cleft in the disintegrated granite of Sherman Hill. This divide is at an altitude of 8235 feet and is the highest pass on the Union Pacific line across the Rockies.

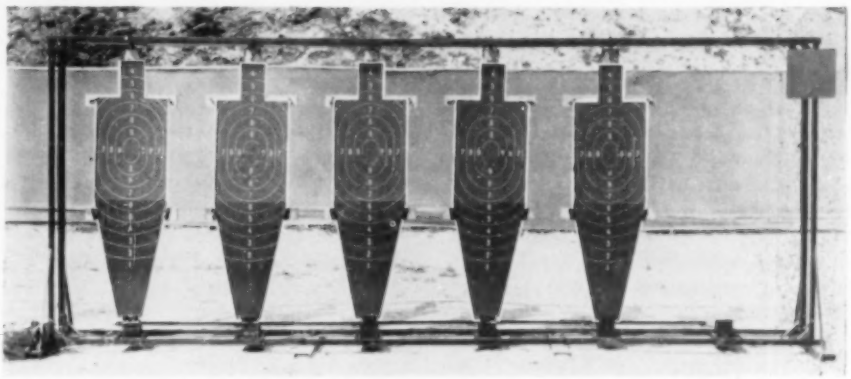
Stone shot down at the quarry face is loaded into 10-ton Euclid trucks by two power shovels: a P & H 5-yard all-electric and a 2½-yard Bucyrus-Erie diesel. It is hauled to the crushing plant, where it is first reduced to a maximum size of 9 inches in a 42-inch McCully cone crusher. The product is screened to remove dirt and fines and the remainder is conveyed to a 7-foot Symons cone crusher that reduces it to a maximum of 2½-inch size. This material is delivered to a 20,000 cubic-yard stockpile over a tunnel containing a conveyor belt that provides controlled feed to three secondary Symons cone crushers: one 5-foot and two 4¼-foot units. The ballast thus produced is of one grade: 1¾ inch minus to ½ inch plus. It is delivered by belt to a main stockpile, from which it is loaded into cars as ordered by the railroad. Some screenings or chips that are obtained as by-products during the sizing process are also shipped to be used in mastic placed at crossings, on station platforms, etc. An excellent grade of heavy riprap is likewise produced by selecting suitable pieces when the blasted rock is being loaded into trucks at the quarry face. This is stockpiled and shipped out as ordered.

F. E. Newell is project manager of the operations for Morrison-Knudsen at Granite Canyon. Ted Lewandowski is plant superintendent, and John Dissaro is quarry foreman. The production and use of the stone by the Union Pacific is under the general supervision of W. C. Perkins, chief engineer.

# Air Power Turned Targets at Olympiad





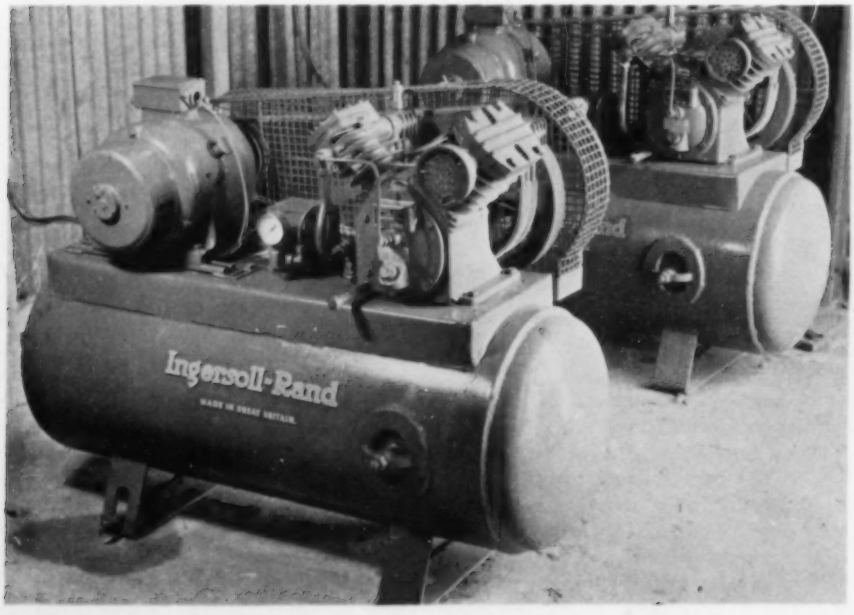


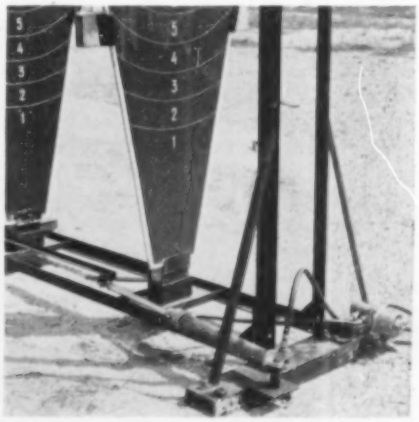
**TARGET CONTROL STATION**

The dial in the center of the box was set to display the targets for a specified number of seconds. When the operator pressed the button on which his thumb rests, the targets automatically snapped into shooting position and back out of view. The lines leaving the box extend to the air-cylinder control valve. The pictures at the right show the targets standing edgeways to the eye (top) and in shooting position.

UPON being told that compressed air was used in connection with one of the sports events at the recent London Olympiad, the immediate response would probably be: "Whatever for?" Why, for the rapid-fire pistol-shooting contest at targets that were positioned edgeways to the participants before the starting signal was given. Turning of the targets at the 1948 games was controlled with equipment of the electronic type designed by technicians of the Royal Air Force and was done with a precision that amazed the managers of the shooting teams who came to check the timing mechanism with stop watches. As the R.A.F. expressed it: "That was like someone asking us to check our stop watches by means of an old alarm clock."

There were four batteries of five targets each at the shooting range and each battery was provided with a solenoid-controlled air cylinder. The piston rod of the latter was connected to a long angle iron to which were bolted a series of bell cranks, one at the base of each target. The electronic control equipment is encased in a metal cabinet. Seated in front of this station, the operator pressed a button on the front panel, thus actuating the solenoid valve that admitted air to the cylinder. Automatically, the targets were given a quarter turn and, after remaining visible for a predetermined length of time, snapped back to their original position. Compressed air for the purpose was supplied by two 3-hp. Type 30 machines mounted on 20x48-inch horizontal air receivers. These units were loaned to the committee by Ingersoll-Rand Company, Ltd.

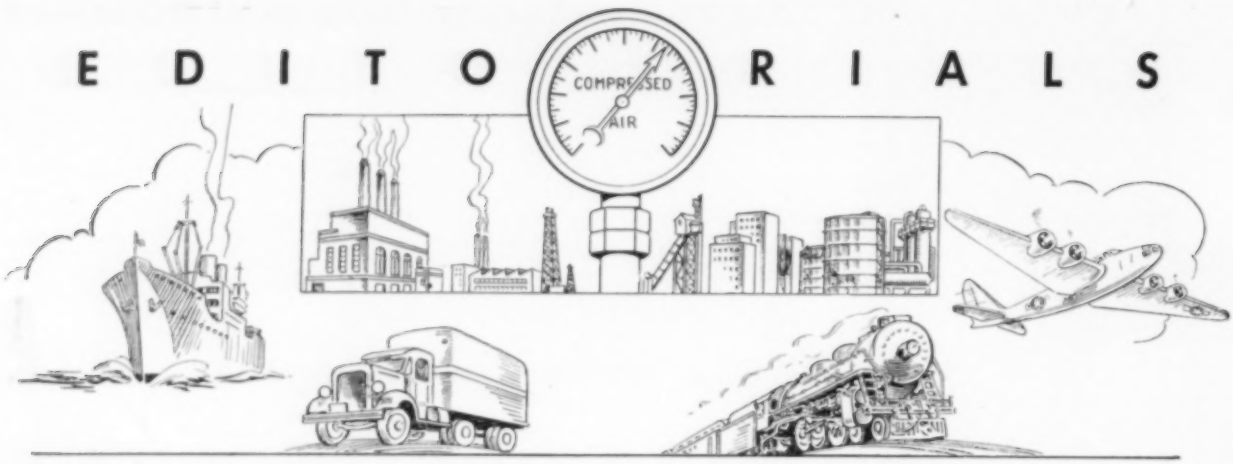



**HOW TARGETS WERE TURNED**

Above, extreme right, is the valve that controlled the admission and exhaust of air from the cylinder in the foreground. Through connecting linkage the piston turned the targets 90° and back to their original position. The compressors that supplied the air are at the left.

# EDITORIALS




## CONSERVING OUR RESOURCES

EXCEPTING times of war, Americans have seldom had to conserve natural resources. Our periods of rationing and shortages have been too brief to impress us seriously. The average citizen takes it for granted that somebody will somehow keep us supplied with metals, fertilizers, water, and other requisites for a life of comparative ease. If there is a shortage of oil for heating his home, he can switch to coal. Or, if this is financially or economically not feasible at the moment, he can buy relatively inexpensive electric heaters.

Our nation has been generously endowed by nature, but we are beginning to run low on some essential materials. Another war on the scale of the recent one would find us scraping the bottom of some of the barrels that we once thought were inexhaustible. There is every reason that we give heed to the problem now instead of waiting until an emergency arises.

Conservation does not mean stopping the use of something that is scarce, but rather using it with discretion. Materials derived from growing things are capable of replenishment through replanting. Others such as metals and petroleum are in a different category. Fortunately, science has developed ways of making gasoline artificially, but it will no doubt be more expensive than the fuel we now have. No one has yet discovered means of creating metals, although the nuclear scientists may someday solve the riddle of transmutation on a commercial basis.

In the meantime, it is incumbent upon us to put into effect some organized scheme of husbandry. This involves a program of education. Actually, it is important to save scrap during peacetime, but the present shortage of this material is proof that too few people are aware of that fact. Engineers, too, can do a good turn for conservation by specifying substitutes for scarce materials wherever this is possible. Plastics can be employed instead of metals for many purposes without an appreciable loss in efficiency. But if metals are essential, they can be protected against erosion and corrosion by metallurgical processes such as electroplating. Even wooden structures can be safeguarded against decay by applying coats of paint at the proper time.

This, however, is not a program for the individual. Each person can help by using common sense, but the movement needs the organized guidance of the Government. Bills designed to bring this about have been introduced in Congress but not passed. Others will be put before the solons next January, and it is to be hoped that they will receive the consideration they deserve.

## PRECIOUS WATER

A CENTURY ago California was searching for gold; today it is seeking water. Gold founded and nurtured the vast Western Empire, but only water can sustain it now. Southern California, which once advertised for more people, would now perhaps like to close its gates, but can't. Having gained momentum, the flow of population to that climatically favored area continues unabated, and no one can foretell when it will slow down. Meanwhile, authorities are striving frantically to cope with a water problem that grows more serious day by day.

When plans were put underway to convey Colorado River water 400 miles to the Los Angeles section, this potential supply line was looked upon as of purely supplemental importance. Most of the coastal-plain communities were pumping nearly all the water they needed from underground. Since then, unprecedented eras of drought have lowered the water table drastically, and in the same period spectacular influxes of people have added to the gravity of the situation.

Almost providentially, the 200-million-dollar Colorado River Aqueduct was completed in time to serve the vital war industries that sprang up in Southern California after the Pearl Harbor attack. More and more cities turned to this gigantic hose to slake their thirst. This has gone on until the aqueduct is no longer considered a supplemental medium of supply. Instead, it is openly called the region's life line.

When the aqueduct went into service in 1941, thirteen municipalities elected to take water from it. Now it is serving 26. In the meantime, the aggregate population of the original thirteen users has increased by more than a million and is now estimated at around 3½ millions. Their assessed valuation has more than doubled and today stands at 3½ billion dollars. This increase is attributable largely to the establishment of additional industries, all of which are dependent for their existence upon a continuing supply of water.

In 1941 the aqueduct carried an average of 8,370,000 gallons of water daily. During 1948 the daily average will be around 134,000,000 gallons. The most recent customer to be added is San Diego which, last December, put in service a 71-mile connecting aqueduct that was pushed to completion by the U. S. Navy because of its stake in defense plants in the area concerned.

A change in the weather cycle would lighten but not solve the problem. Theoretically, Southern California gets 15 inches of precipitation annually. Actually, it received only 4.13 inches in 1947, which was the driest year since the keeping of weather records started 70 years ago. A return to normal rainfall conditions would partially replenish the underground reservoirs and permit them to be drawn upon for a substantial proportion of the needs. In 1941 these subterranean sources contributed such a large share of the requirements that only 4 gallons of water per capita had to be delivered from the Colorado daily. This year the river is supplying around 41.

In the face of this situation, California is vigorously seeking a permanent Supreme Court allocation of Colorado River water for the three southern-basin states. The Colorado is literally and figuratively the "last ditch" for Southern California, and the region's continued growth is intimately bound up with the establishment of water rights that will provide a surplus for the future.

# This and That

**Fires from Tires**

Fires consumed $2,000,000 worth of motor vehicles and equipment in 1946. Some of them are attributable to tires, especially to those on the rear of semitrailers. They are usually started by running a tire flat or with little air pressure, in which condition repeated flexing generates heat that eventually causes the tire to burst into flames. The air temperature, direction of the wind, and speed of travel all have a bearing on the incidence of overheating. The obvious preventive is to keep tires inflated properly and to remove foreign, friction-inducing objects from them.

★ ★ ★

**Broadening Utility of Plastics**

A transparent plastic that can be heat treated much as metals are to condition it for certain applications is announced by The M. W. Kellogg Company. It is similar in structure to the hydrocarbons of petroleum, but resists chemical attack because the hydrogen is replaced by fluorine and chlorine, which make up four-fifths of its weight. The plastic, called Kel-F, is therefore unusually stable and unaffected by acids and alkalies. These attributes suggest its use as pump and valve packings and valve seats in equipment handling corrosive liquids or gases, as well as for laboratory and instrument tubing. It has good "cold-flow" characteristics, which means that it deforms slightly under pressure but returns to its original shape when the pressure is released. This property indicates that it is suitable for making seats for air or gas safety valves which are closed for long periods.

A New Jersey firm is now manufacturing washbasins and sinks from Lucite, a du Pont plastic. These products are formed by a process combining blowing, pressing, and vacuum-drawing. The basins range in weight from 1¼ to 7¼ pounds, and models are available for airplanes, trains, autotrailers, and homes. The material is affected by a few household chemicals, but tests indicate that it has a long life under normal service conditions. Abrasive cleansers will scratch its surface, but they are unnecessary because Lucite can be cleaned with soap and water.

The newest use for nylon is as a textile machine part known as a flyer block. The spindles of the conventional blocks require lubrication, and as they whirl at from 8000 to 15,000 rpm., there is a tendency for them to throw oil on the yarn. As nylon blocks need no lubrication, this cause of yarn spoilage is eliminated.

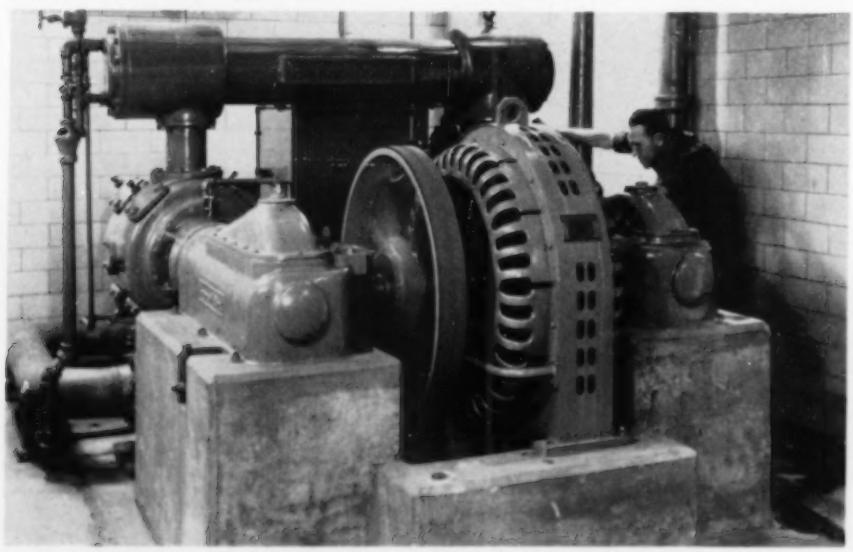
★ ★ ★

**Underwater Tunnels in South**

The increase in automobile traffic has made the South tunnel-conscious. Crossings over waterways are becoming bottlenecks when bridges are open to let boats through and, lacking elevated points that will permit erecting high-clearance spans, subaqueous bores offer the most practical solution. Mobile, Ala., initiated the trend when it built a $4,000,000 tube underneath the Mobile River just prior to the recent war.

Now Houston, Tex., is constructing a 3400-foot tunnel under the ship channel that connects it with the Gulf of Mexico. It is expected that the bore will cost $7,500,000 and be ready for service in eighteen months. Galveston, Tex., has taken bids on a mile-long tube under the bay. It is estimated to cost $17,000,000 and will involve the building of an artificial island 2000 feet long and of 4000 feet of trestle approach. New Orleans is planning an $8,500,000, four-lane tunnel under an intercoastal waterway. Jacksonville, Fort Lauderdale, and Miami, Fla., are all considering such passageways to solve traffic congestion. Norfolk, Va., is talking about a bore under its ship channel, and Baltimore, Md., is trying to decide between a bridge and a $45,000,000 tunnel to carry cars across Chesapeake Bay.

The success of the Mobile tube is largely responsible for the current activities. Wilmerding & Palmer, Inc., of Mobile served as engineering and financial consultants on that pioneer southern bore, and Wayne F. Palmer of that concern has since formed the firm of Palmer & Baker, Inc., which designed the Houston and Galveston tunnels. The Mobile crossing was built by assembling steel tubes in sections, sinking them in an excavated trench, and then joining them. Since it was opened in 1941 it has carried fifteen million vehicles without an accident. Tolls are now netting around $450,000 a year over and above operating expenses.



**LUNGS OF A RESEARCH CENTER**

The main laboratories in the new research center of The B. F. Goodrich Company at Brecksville, Ohio, are divided into 112 rooms, each 10x26 feet, by steel partitions that can be moved to combine any number of them into a larger working space. Each room is provided with gas, electricity, water, steam, and compressed air. The last-named utility is piped from the Ingersoll-Rand synchronous motor-driven compressor shown above.

★ ★ ★

**Pressurized Oil-filled Power Line**

Compressed air was used in several ways during the recent installation of one of the few 138,000-volt, high-pressure, oil-filled pipe-line cables in this country for the transmission of power. The San Antonio (Texas) City Public Service Board put in 58,675 feet of the underground cable to connect its "B" steam-turbine generating station with the outlying Olmos and Grandview substations. The 7½-mile Olmos line is one of the longest of its type so far put in service. The Grandview cable is about 3¼ miles long.

The enclosing steel pipe is 5 9/16 inches in outer diameter and has a .258-inch wall thickness. It was shipped in 40-foot lengths fitted with bell-and-spigot ends to insure a smooth inside finish. Prior to field welding, the inner surfaces of the ends were wire brushed with pneumatic tools and swabbed with oil to remove rough spots. Segments up to 1770 feet

long were joined before testing the pipe for leaks and running in the cable. Testing was done with air at 400 psi. pressure supplied by an Ingersoll-Rand Type 20 high-pressure compressor. To insure dry air, special equipment was used to remove entrained moisture. One end of each section was left open until the escaping air reached a dew point of minus 40°F. It was then closed and the internal pressure built up to the prescribed level.

Ordinarily, cable is pulled in by a pilot wire that is pushed through each pipe length prior to welding and spliced to the one that precedes it. In this case, however, the cable was run through the entire welded segment of up to 40 pipe lengths and more by air pressure. At first, a wooden dumbbell-type "rabbit" was blown through with a pilot line attached to it. This went so easily that a closer-fitting "rabbit" was made from two rubber pistons and a connecting rod. The three electric cables were fastened to this and were found to move ahead readily under air at from 10 to 12 psi. pressure.

As a further precaution against admitting moisture into the line, the cable was shipped to the job with lead covering. This was stripped off and reclaimed as the cable was introduced into the pipe. Special insulating oil for filling the latter was delivered in five 10,000-gallon tank cars, which were first decontaminated and dried. The space on top of the oil was charged with nitrogen to exclude moisture-containing air during transit. Nitrogen was also put in the pipe as the cable was drawn in. When in place, the remaining space in the pipe was filled with the oil, which is maintained under 200 psi. pressure by pumps in the power station. The line was installed by General Electric Company.

* * *

**New 20th Century Limiteds**

Since June 15, 1938, the New York Central Railroad has been running a Twentieth Century Limited daily each way between New York and Chicago and it has probably become the best-known high-speed train in the world. On September 17, two new Limiteds went into service, replacing those that had been operated for a decade. They represent an expenditure of $4,000,000 and incorporate the most modern equipment available for rail transportation. The trains are drawn by diesel-electric locomotives at a top speed of 85 miles per hour on the same time schedules that have been in force for some years. All cars are connected by telephone, and between New York and Buffalo, a distance of 435 miles, passengers may place long-distance calls by radio-telephone. Relay stations that will extend the service the length of the trip are not yet installed. Foam-rubber seats and mattresses, fluorescent lamps, and circulating ice water are some of the luxuries provided for travelers. Jerky starts and stops are eliminated by tight-lock couplings. An alarm system warns trainmen of impending hotboxes in the roller-bearing journals; and electropneumatic brakes automatically vary their pressure in accordance with the train speed. Compressed air opens the car doors when bars on them are pressed down slightly.

* * *

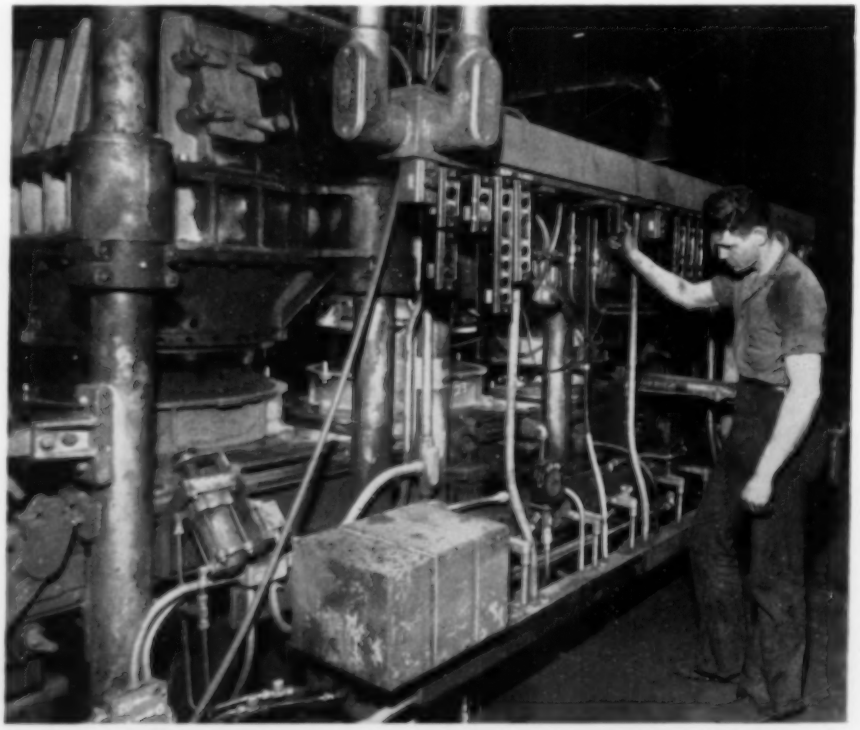
**Salvage of "City of Lincoln"**

How a badly damaged 12,000-ton vessel was kept afloat for months by continuously pumping compressed air into the hull is briefly described in *The Stabilizer* published by The Lincoln Electric Company, Cleveland, Ohio. Last December, the ship *City of Lincoln* went on the rocks near Danger Point, Cape of Good Hope, South Africa. It was abandoned by the crew, and salvors immediately took over, but they were hampered by heavy seas. After the cargo of 1000 tons had been taken off, all bulkheads, openings, etc., were closed by welding, and compressors began to fill the hull with air to exclude the water that was coming in through rents in the bottom. After four months, the vessel was floated clear of the rocks. It was towed 100 miles to Cape Town, with eleven compressors continuously operating to keep the water out. Even after it had been docked, six machines remained in service until the torn bottom plates could be made watertight.

* * *

**Coeur d'Alene Wealth**

Relatively few mining areas have shown the concentrated mineral wealth of Idaho's Coeur d'Alene District. The U. S. Bureau of Mines gives it a total output valued at more than 1200 million dollars, or an annual average of nearly nineteen million dollars for its 64 years of production. Individual metal yields are: gold, 395,874 ounces; silver, 441,522,330 ounces; copper, 59,526 tons; lead, 5,680,512 tons; and zinc, 1,343,703 tons. The ore bodies show no indication of playing out with depth, and deposits now being opened more than 3000 feet beneath the surface are fully as large and rich as those at higher levels. The district has 33 ore-processing mills, with an aggregate capacity of 13,075 tons of material a day.



**PUSH-BUTTON FOUNDRY MOLDING MACHINE**

This machine automatically produces multiple sand molds for pouring castings and stacks them six high ready to receive the molten metal. It is used in the Cleveland, Ohio, plant of the Westinghouse Electric Corporation and was developed by that concern and the International Molding Machine Company. All operations are performed in proper sequence by compressed air and hydraulic power under complete electric timing and control. First, sand is blown into a flask to make a preform of a mold. Next, the sand is squeezed around a drag pattern in the flask bottom under a pressure of 50 tons by a head carrying a cope pattern. Then the drag pattern is removed and the flasks are stacked preparatory to moving them by conveyor to the pouring platform.

# Industrial Notes

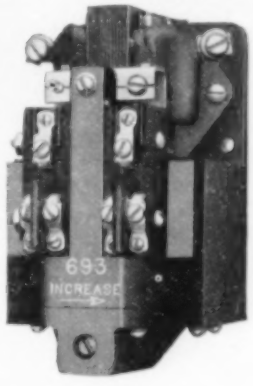
Although atomic-energy power plants are some years in the future, a short name has already been coined for them. It is "nuen," derived from the first syllables of the words nuclear and energy. It was coined by the Kellex Corporation for a display model prepared by it under the auspices of the Atomic Energy Commission.

The American Can Company has developed a machine to test the tenderness of peas as they are canned. Called Tenderometer, it computes and indicates the force required to cut through peas with keen knives. Permission to manufacture the device without payment of royalty has been granted canners of this country and Canada.

The United States Rubber Company heats a new 30x50-foot sandblasting room with wrought-iron pipe coils embedded in the concrete floor. This eliminates exposed pipes and heating elements on which fine sand accumulates. Metal tanks are cleaned in the room before they are coated with rubber.

Test cross lines of a new traffic paint showed little evidence of wear after two months of service at a highway intersection in Camden, N. J., that is considered to be the second busiest one in the state. Lines laid with paints currently used were almost obliterated in the same period. The new paint is a development of Hercules Powder Company.

A pneumatic timer for machine tools, conveyors, automatic processing equipment, etc., had been produced by Cutler-Hammer, Inc. Measuring 2¾ inches in width and 4⅞ inches in height, the device fits into restricted spaces. Adjustment covers a range of from 0.3 seconds to 3 minutes, and reset is well-nigh instantaneous. The unit is available with




either one or two timing steps. With the latter, individual adjustment of each step permits performing two separate timing functions on one instead of two relays.

A new magnetizing unit promises to be a household boon. It will magnetize screw drivers so that screws can readily be held while being inserted in inaccessible places. Women can magnetize scissors with it to pick up pins. The unit plugs into any electrical outlet and also demagnetizes.

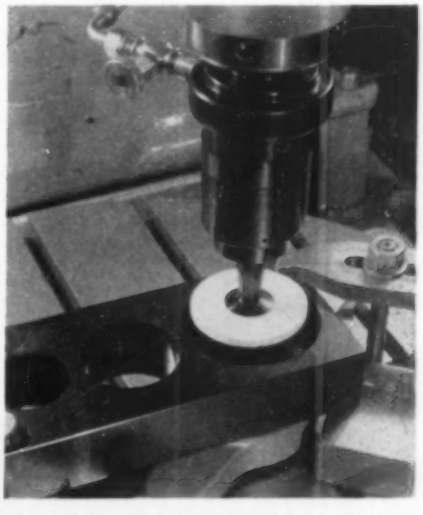
The Copper & Brass Research Association reports that the Bell Telephone network is made up of 113 million miles of wire, enough to encircle the globe 4520 times. There are 433 parts in a telephone, many of them of copper, brass, or bronze. The nation's 30 million telephone sets therefore contain approximately 13 billion parts, not including those in the phone system itself.

New 10-car stainless-steel trains now being constructed for New York City's subway lines will have fluorescent lights, illuminated station maps, and a public address system to announce station stops. Their antifriction journal bearings will run from 100,000 to 150,000 miles between inspections, as compared with the present average of 2000 miles.

The rubber division of Raybestos-Manhattan, Inc., recently supplied a southern chemical plant with a 300-foot flexible rubber hose 18 inches in diameter for carrying slurry through a tunnel. It was shipped in twelve 25-foot lengths, each weighing 1425 pounds. This is believed to be the longest large-diameter hose ever made.

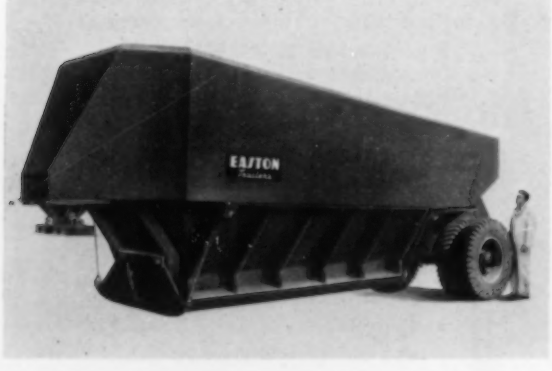
Molykote is the name of a new dry-type, high-pressure lubricant produced by The Alpha Corporation. Composed mainly of molybdenum-disulphide powder, it is said to have an extremely low coefficient of friction and the capacity to prevent galling, seizing, or metal-to-metal contact at bearing pressures of more than 100,000 psi. It is reported to work equally well at high or low sliding velocities, to stand up under extremes of temperature, and to cling tenaciously to smooth metal surfaces. Ten ounces of the lubricant will coat 500 square feet. It may be used as a powder or, mixed with S. A. E. No. 10 motor oil, as a paste. It is available in 10-ounce shaker-type cans.

Pictured is a new Vulcanaire—an air-driven attachment manufactured by Vulcan Tool Company and used for converting machine tools such as jig borers and vertical mills into precision grinders. It is the second model and is designed for grinding holes ranging in diameter from 1½ to 4 inches in hardened steel. The original unit grinds holes from 1/16 to 1½ inches in diameter. Both are



equipped with interchangeable adapters which enable them to fit the chucks of most types of machine tools. Accessory equipment used with the attachment includes an air cleaner, a regulator, an air gauge, an oiler, and a dust collector, all of which are mounted on a portable stand that can be placed near the work.

A few years ago, George N. Jeppson, chairman of the board of directors of Norton Company, Worcester, Mass., conceived a new process by which abra-




**HEAVY-DUTY TRAILER**

Shown here is the model TB-4030 bottom-dump trailer which the Easton Car & Construction Company has recently added to its line of heavy-duty equipment. Designed to haul 32-ton loads of bituminous coal in strip-mining operations, the vehicle features a radial, air-powered gate that can be controlled either from the cab of the tractor or from the rear of the trailer. Wheels are fitted with 16:00x24, 24-ply, lug-type tires and brakes are air operated.

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THE NEW "VIC-GROOVER" grooves pipe ends twice as fast as ordinary pipe threaders . . . with half the effort. It's light-weight and ratchet operated . . . grooves exactly right *automatically.*

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sive grinding wheels could be made faster and better than they were then being produced. The company's development engineers proved his ideas sound by turning out wheels experimentally in hours instead of days. When a pilot-plant test also was successful, ground was broken for a $4,300,000 factory in April, 1947. Although only recently dedicated, it and the pilot plant combined have already made ten million wheels by the new method.

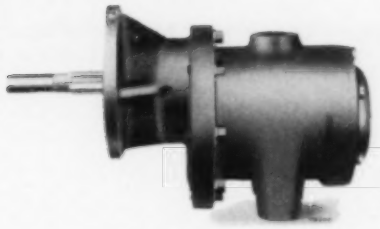
A small hand truck for moving boxes, cases, etc., has been placed on the market by Techtmann Industries. The Hook-'N-Haul, as it is called, has a tilting carrier rack of parallel steel plates and is arranged so that forward movement of the truck handle places it in the loading position. An arm extending from the handle is fitted with two hooks. The bottom one is used to grab wooden cases

and boxes, while the top one engages handles on metal-clad containers. When the load is hooked, the operator pulls the handle backward, causing the load to slide onto the carrier rack. To discharge the load, he gives the hook arm a slight push, thus overbalancing the rack and allowing the load to slide onto the floor. The truck is of all-steel construction and is equipped with one swivel and two stationary casters.

Wearing an M.S.A. Coolband prevents perspiration from dripping into eyes and on glasses and goggles. Made for industrial use, it is a light-weight sponge-rubber band that is said to fit without binding and can be cleaned with soapy water and sterilized.

Included in the conveniences of an automobile bus used for special traveling missions of the personnel of Goodyear Tire & Rubber Company is a circulating water system that supplies a kitchen, shower bath, and lavatory. The pressure of compressed air, obtained from the braking system, forces water from an 80-gallon tank through the pipes to the various outlets.

Small and compact air motors to serve as starters for internal-combustion engines are now being built by Ingersoll-Rand Company. Of the Multi-Vane type, the units are made in two sizes that



develop 9 and 20 hp., respectively, when operated with air at 90 psi. pressure. The throttle valve used is of the quick-opening kind to develop peak horsepower almost instantaneously. Suitable speed reduction is obtained by single-step spur gearing between the motor and the drive shaft, which is keyed or splined to the Bendix or starting mechanism of the engine.

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Clay crucibles possessing properties that make them especially suitable for smelting high-lead glazes and enamels have resulted from two recent developments at the National Bureau of Standards. One of these is a new composition that gives the body of the crucible an improved structure. The other, an added step in the lining procedure, aids in sealing invisible, incipient cracks. The usual clay crucible is porous and therefore subject to penetration and attack by highly corrosive melts. By contrast, the pores in the new one are very small and the interconnecting passages between them so minute that they effectively resist the flow of molten fluids.

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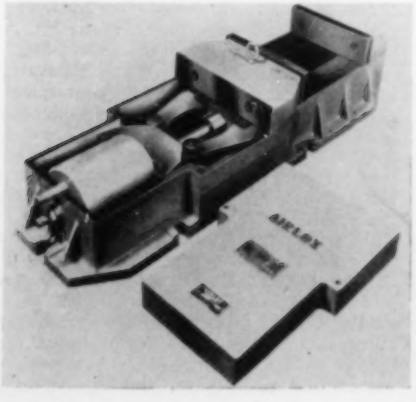
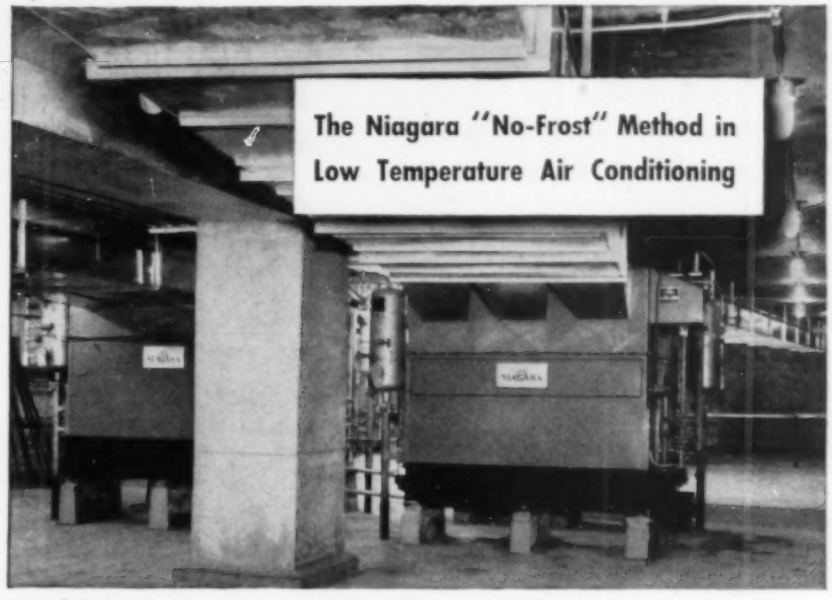
Production Devices Incorporated has announced a new model in its line of Airlox vises. Designed primarily for use in connection with milling machines of 40 to 50 hp., the Airlox Senior exerts a jaw squeeze 200 times the applied air pressure. Thus an operating pressure of 100 psi. results in a grip of 10 tons per square inch on the work. The vise is designed so that air at 200 psi. can safely be applied if maximum gripping force is desired. It is 45 inches long, 13⅛ inches wide, 8¾ inches high, and weighs approximately 575 pounds. Jaws are 10½ inches wide, 3 inches deep, and have a maximum opening of 12 inches. The jaw stroke can be adjusted from a minimum of 1/16 inch to ⅝ inch.





# Making or Holding Products Uniform

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● Specializing for thirty years in the more difficult problems of air conditioning for industrial processes, this Company has developed a group of units that make it easier and less expensive for you to get the particular air conditioning benefits you may need for your special process, or to overcome some obstacle of climate or condition that is interrupting your production or causing loss from rejected parts or materials.

The Niagara "No-Frost" Method, for example, has been used to create temperatures as low as -90°F. in cold test rooms, and to provide air with only 1 gr. of moisture per lb. for special processing.

The Niagara Type "A" Air Conditioner creates any condition of temperature and humidity for a test or process, and if wanted, creates different conditions in different rooms simultaneously.

Some of the industrial applications of these units: internal combustion engines, motors and air craft, super-chargers and carburetors, gas cooling and controlled atmosphere process, film, plastics, fiber, rubber and adhesives control, biological processing such as penicillin, and yeast.

*Write for a Niagara Blower Bulletin on a subject which interests you, or for the address of the nearest Niagara Field Engineer.*

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**MICRO-KLEAN fibre cartridge where it must make hundreds of sharp turns through minute interstices, impinging on fibres.**

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**Moisture then drains from non-wicking fibres into extra-large collection chamber, equipped with petcock drain.**

Standard Micro-Klean models handle volumes up to 80 cfm of free air and pressures up to 125 psi. They have been adopted as standard equipment on such widely divergent applications as pneumatic mine-equipment, powder dispensing devices, motor coach auxiliary air systems, spray painting systems, air instruments, etc. For more information, attach coupon to your letterhead.

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## Industrial Literature

Light-weight air hose for use with hand-held pneumatic tools is the subject of a folder issued by B. F. Goodrich Company, Akron, Ohio. The hose, which is made in five sizes ranging from ⅜ to ½ inch, is claimed to weigh half as much as the conventional type and to be extremely flexible. The folder describes the construction of the air hose and lists its advantages and applications.

Pyott Foundry & Machine Company, 328 North Sangamon Street, Chicago 7, Ill., will send upon request a catalogue containing the latest prices, descriptions, and specifications of its cast-iron pulleys made to meet any commercial requirement. Units up to 60 inches in diameter with face widths of 22 inches are machine molded, larger and unusual sizes being machine swept and cored or made from patterns.

A new catalogue of the Heise Bourdon Tube Company, Inc., discusses improvements in design and gauge movements which have increased the working range of its Bourdon tubes. The pressure gauges are made in three diameters—8½, 12, and 16 inches—and are individually calibrated from standard pressures in ranges from 0-15 to 0-10,000 psi. Accuracy is guaranteed to equal one part in 500 and is greater than in the case of tubes for pressures exceeding 10,000 psi. The gauges are available for use in various pressure media, including mercury. Copies of the booklet may be obtained from the company at Brook Road, Newtown, Conn.

Obtainable from Ingersoll-Rand Company is Contractors' Combination Catalogue, a 40-page publication listing and describing equipment built by it for the contracting, mining, and quarrying industries. Rock drills, Jackhamers, paving breakers, pile drivers, concrete vibrators, hoists, pumps, compressors, and reconditioning equipment for Jackbits and drill steel are covered, as well as accessory equipment necessary for their operation. Requests for Form 202 should be addressed to the company at 11 Broadway, New York 4, N. Y., or any of its branch offices.

*Speed Packing Manual*, which is issued by Sherman Paper Products Corporation for shippers of industrial products, recently underwent its sixth revision and is now ready for distribution. The current edition, illustrated with nearly 200 photographs and drawings, gives detailed instructions for packing a variety of things ranging from clothing and jewelry to automobile parts and prefabricated houses. A section on corrosion prevention, based on wartime packing experiences, is intended for manufacturers and shippers of highly finished metal products. Copies of the manual will be sent upon request to the company at Newton Upper Falls 64, Mass.

Electric Machinery Manufacturing Company, Minneapolis 13, Minn., has issued a series of bulletins describing and illustrating its induction and synchronous motors suitable for work such as driving boiler-feed pumps, pumps for oil pipe lines, refinery pumps, centrifugal blowers, compressors, and large tube mills. Heavy-duty, squirrel-cage induction motors are dealt with in Bulletins No. 1300-PRD-189 and No. 1300-PRD-190, the former covering motors with four or more poles in horsepower ratings of 100 and more and the latter listing 2-pole motors with ratings of 200 hp. and larger. No. 1200-PRD-175 describes low-speed synchronous motors up to 5000 hp. in size and No. 1100-PRD-181 high-speed synchronous motors of 30 to 5000 hp.

*Research keeps*
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# 50% weight reduction in hose line speeds air tool operations

## *New hose by B. F. Goodrich halves weight, adds flexibility and strength*

NEW B. F. Goodrich Highflex hose for small air tools is twice as light yet stronger than ordinary air hose. 50% weight is saved by use of a thinner wall which actually has *higher* burst strength than heavy old-type hose of equal capacity. Here's a hose that's light and flexible as a lamp cord.

***Saves 50% weight***—Highflex weighs 50% less than ordinary air hose. A 100-ft. length of Highflex hose weighs 8.8 lbs. in ¼" size; ordinary hose of the same size weighs 20 lbs. And substantially similar savings are made in all sizes of Highflex.

***Easier to use***—The greater flexibility of Highflex hose makes it easier to handle, to use in close quarters, to keep kinkless. Lightweight line and better handling qualities reduce fatigue of the operator, make air tool operations faster and more economical.

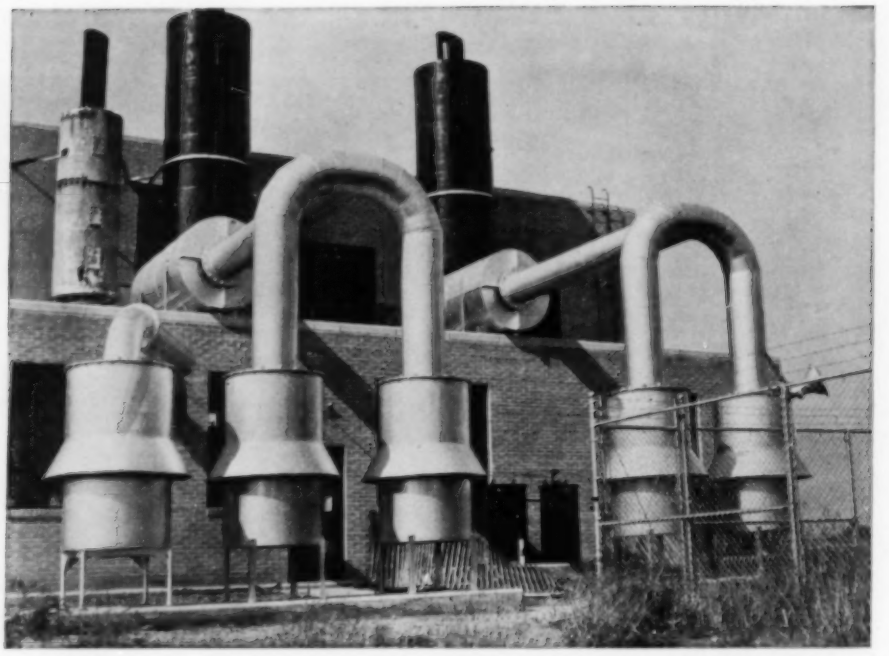
***Strength under pressure***—Highflex has a working pressure of 250 lbs.—a high margin of safety for any small air tool. Braid placed at an angle that insures low expansion under pressure.

***Completely oilproof***—Highflex hose is completely oilproof, on the inside and outside. Lubricating oils won't cause Highflex to swell and flake, cutting air volume or jamming the tool.

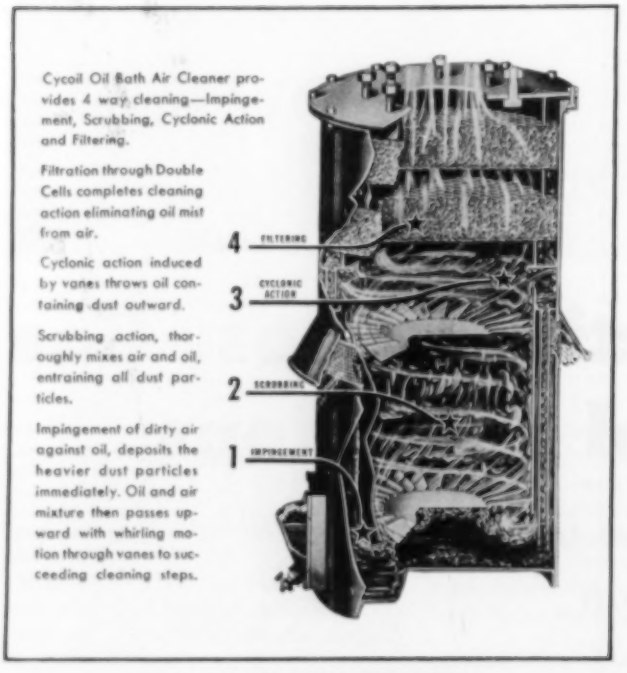
***Other Highflex features***—Cover resists sun checking, tearing and snagging, and abrasive wear. Smaller bulk takes up less storage space. Highflex comes in attractive red color of high visibility. Ask your distributor for prices and full details, or write: *The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio.*

**B.F.Goodrich**
**RUBBER FOR INDUSTRY**

# AIR IS FREE



# ...but not from damaging dust


Cycoil Oil Bath Air Cleaner provides 4 way cleaning—Impingement, Scrubbing, Cyclonic Action and Filtering.
Filtration through Double Cells completes cleaning action eliminating oil mist from air.
Cyclonic action induced by vanes throws oil containing dust outward.
Scrubbing action, thoroughly mixes air and oil, entraining all dust particles.
Impingement of dirty air against oil, deposits the heavier dust particles immediately. Oil and air mixture then passes upward with whirling motion through vanes to succeeding cleaning steps.
4 FILTERING
3 CYCLONIC ACTION
2 SCRUBBING
1 IMPINGEMENT

*Trade-mark registered U. S. Patent Office

## Cycoil Oil Bath Air Cleaner Eliminates Costly Dust Damage to Engines and Compressors

WISE operators have learned that free air can be mighty costly when loaded with dust and dirt. That's why thousands of engines and compressors are today equipped with Cycoil* Oil Bath Air Cleaners to insure that the air is truly free from these trouble-making particles.

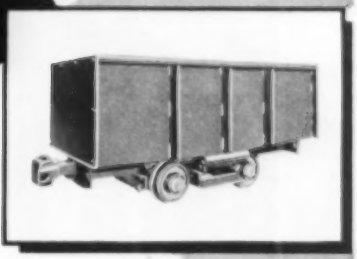
The Cycoil Oil Bath Cleaner leaves nothing to chance. This heavy-duty unit is built to deliver practically 100% dust removal efficiency. Over 90% of the total fine dust content of the air is trapped in a Cycoil even before reaching the filter cell. Positive oil circulation for continued self-cleaning action, plus the additional filtration to be had in the filter pads, assures approximately 100% clean air.

It's a matter of record that wherever Cycoils are on the job at the intake, outgo for costly repairs and shutdowns due to dust damage is a thing of the past. Write today for Cycoil Bulletin 130-D and names of prominent users.

**AMERICAN AIR FILTER COMPANY, INC.**
**402 Central Avenue, Louisville 8, Ky.**
***In Canada: Darling Bros., Ltd., Montreal, P. Q.***

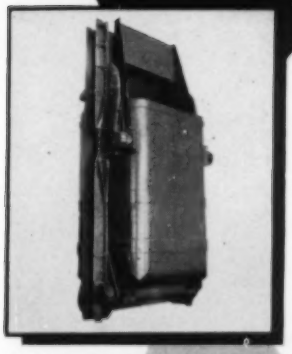
AAF Cycoil OIL BATH AIR CLEANER
AND INTAKE SILENCER

# Look TO LAKE SHORE for Leadership



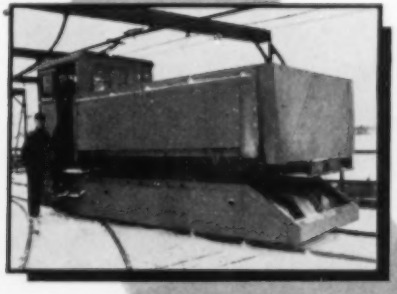
▲ Famous LoHed tram cars for economic hauling of ore and rock. Suitable for all dumping systems.

For seventy-five years Lake Shore Engineering Company has pioneered in the field of custom engineered mining equipment. Our wide experience in engineering and manufacture is available to help you solve your equipment problems. Built by men who know, understand, and live mining, Lake Shore equipment is serving the world. Write today for descriptive catalogs and literature.



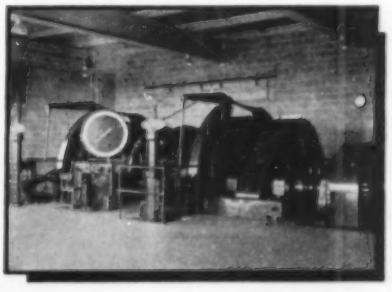
▲ Lake Shore builds steel, aluminum and steel, welded or riveted, skip and cage combinations to suit requirements.

▲ Open, semienclosed and fully enclosed designs of all types cages, steel and aluminum and steel construction.



◀ Three-way or five-way trestle dump cars. Dumps over both sides, end and both corners. A time saver on stockpiling.

Man and material, sinking, sub-level and cargo hoists. All latest improvements for maximum efficiency and safety, engineered to fit any requirement. Sizes to 10-ft. diameter. ▶



▲ Full line of carrying sheaves, rubber lined idler sheaves, split type and rotating shaft head sheaves. Cast iron, plate steel, or plate aluminum construction. Wide range of sizes.

## LAKE SHORE ENGINEERING COMPANY

IRON MOUNTAIN, MICHIGAN

Plants at Iron Mountain and Marquette, Michigan

*Export Division*

60 East 42nd Street, New York 17, New York

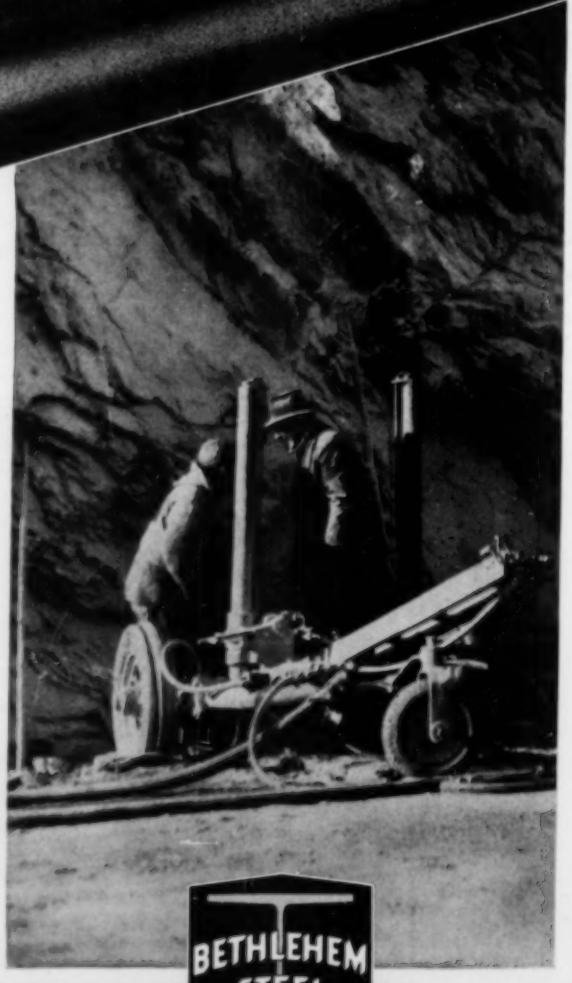
Cable address: LAKESHORE

*Eastern Sales Offices*

60 East 42nd Street, New York 17, New York

Telephone: MUrray Hill 2-3992

# THE BEST STEEL Costs No More



The performance of the drill steel has a lot to do with your costs on a rock job. While there still are contractors who order just "drill steel," far more have learned to rely on Bethlehem Hollow. Their experience has shown them it will stay on the job longer. They order it by name . . . Bethlehem Hollow.

- ★ Bethlehem Hollow is uniform in physical properties.
- ★ It gives tough shanks, sharp bits, and long-wearing threads when you use detachable bits.
- ★ Its wide quenching range means easy heat-treatment for the right degree of hardness and wear-resistance.
- ★ The center hole is smooth and true.
- ★ Best of all, Bethlehem Hollow stays on the job longer.

Immediate delivery of standard sizes from our mill or your nearest supplier.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

## BETHLEHEM HOLLOW DRILL STEEL

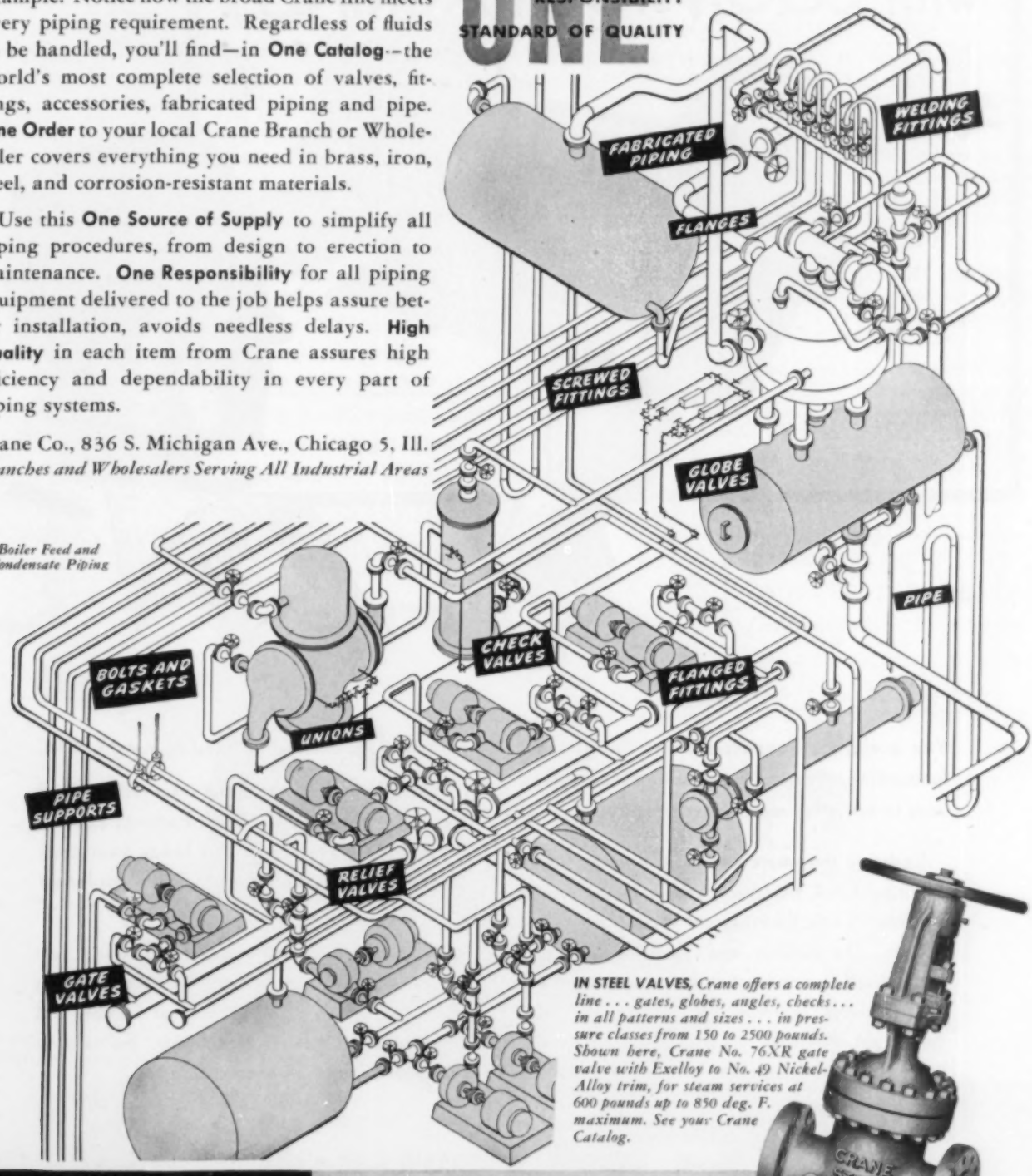
# If it's anything in piping...
# CRANE has everything you need

**Take This Boiler Feed and Condensate System,** for example. Notice how the broad Crane line meets every piping requirement. Regardless of fluids to be handled, you'll find—in **One Catalog**—the world's most complete selection of valves, fittings, accessories, fabricated piping and pipe. **One Order** to your local Crane Branch or Wholesaler covers everything you need in brass, iron, steel, and corrosion-resistant materials.

Use this **One Source of Supply** to simplify all piping procedures, from design to erection to maintenance. **One Responsibility** for all piping equipment delivered to the job helps assure better installation, avoids needless delays. **High Quality** in each item from Crane assures high efficiency and dependability in every part of piping systems.

Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.
*Branches and Wholesalers Serving All Industrial Areas*

ONE
SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY




*Boiler Feed and Condensate Piping*

**IN STEEL VALVES,** *Crane offers a complete line . . . gates, globes, angles, checks . . . in all patterns and sizes . . . in pressure classes from 150 to 2500 pounds. Shown here, Crane No. 76XR gate valve with Exelloy to No. 49 Nickel-Alloy trim, for steam services at 600 pounds up to 850 deg. F. maximum. See your Crane Catalog.*

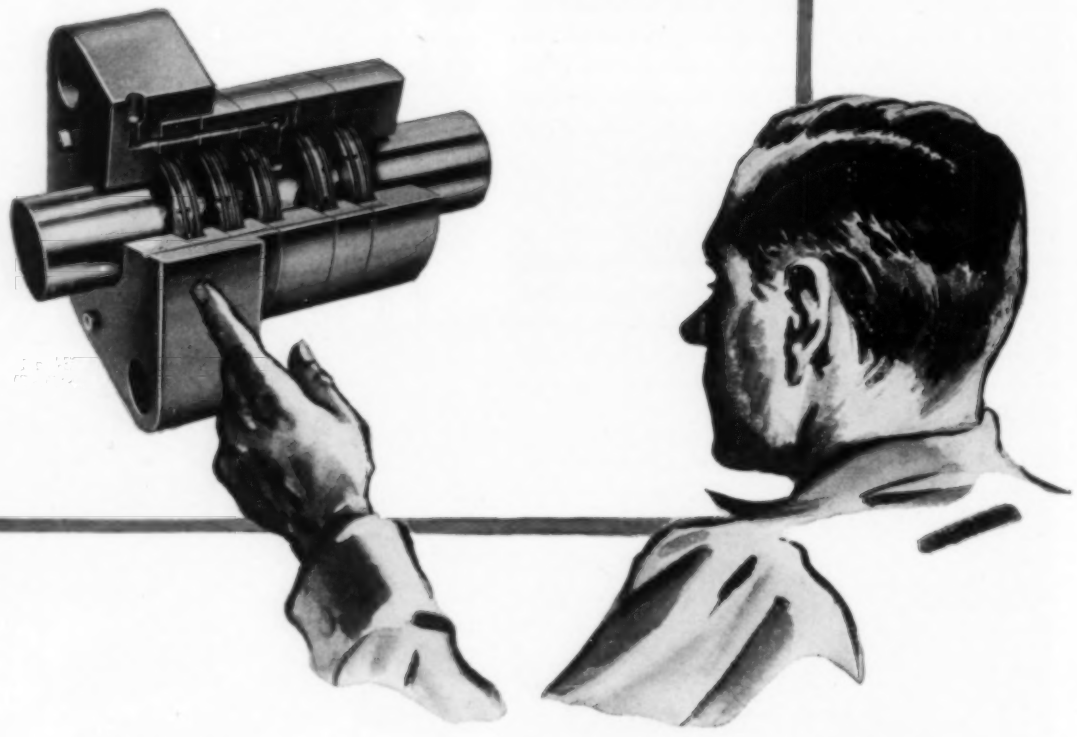
EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

# CRANE

FOR EVERY PIPING SYSTEM

# *Cut the High Cost of Friction with* COOK ROD PACKINGS



You compressor operators know that friction-induced wear reduces compressor efficiency and adds to operating and maintenance costs.

Realizing this, more and more operators insist on using Cook Metallic Packing in their compressors. Cook Packings cut friction to a mere fraction. The packing rings "float" with the rod, automatically compensating for misalignment and vibration and avoiding the friction and wear that might otherwise occur. Their design also insures a constant oil film between the rod and packing rings, eliminating metal-to-metal friction.

Precision built of the finest wear-resisting and wear-retarding materials, Cook Packings assure a long-lasting pressure seal that keeps your compressor delivering more cfm at less cost for longer periods.

Next time you order equipment, it will pay big dividends to specify Cook Packings—they're designed to cut the high cost of friction and maintain high operating efficiencies. For existing equipment, write us direct.

**C. LEE COOK MANUFACTURING CO.**
**INCORPORATED**
**LOUISVILLE, KY.**

BALTIMORE • BOSTON • CHICAGO • CLEVELAND
HOUSTON • LOS ANGELES • MOBILE • NEW ORLEANS
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Sealing Pressures

Since 1888

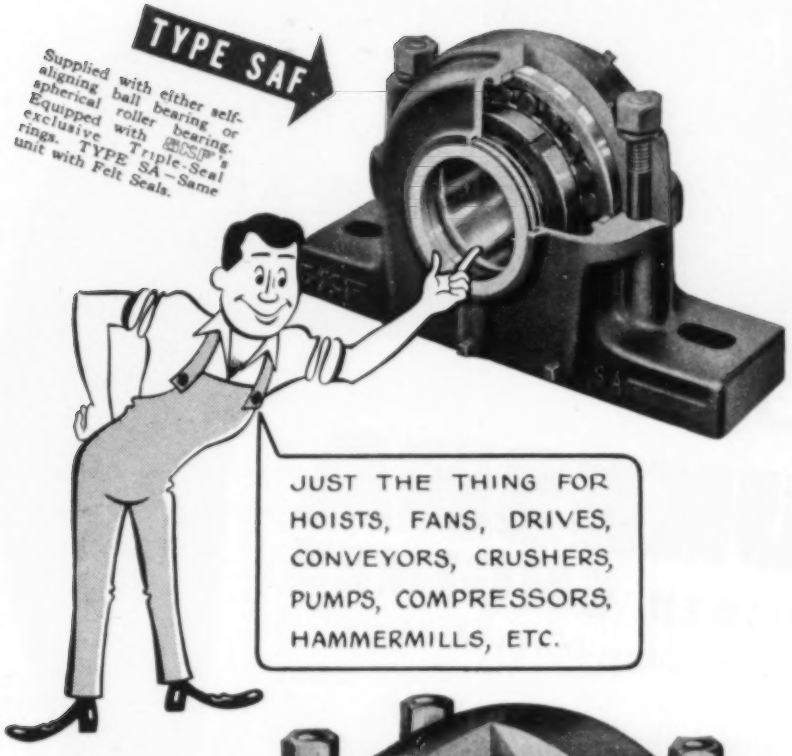
**BETTER PACKING FOR MORE EFFICIENT RESULTS—THROUGH METALLURGY**

# Here's what they're saying about the two HUSKIEST members of

# THE SKF FAMILY OF PILLOW BLOCKS

**TYPE SAF**

Supplied with either self-aligning ball bearing or spherical roller bearing. Equipped with SKF's exclusive Triple-Seal rings. TYPE SA—Same unit with Felt Seals.




JUST THE THING FOR HOISTS, FANS, DRIVES, CONVEYORS, CRUSHERS, PUMPS, COMPRESSORS, HAMMERMILLS, ETC.

"Always get SKF for the TOUGH jobs!" is a byword in mills, mines and factories where these compact, split SAF and SDAF Pillow Blocks and Bearings are now in service.

Consider SKF Pillow Blocks from an engineering point of view: Rugged, easy to install, inspect and lubricate—equipped with SKF's exclusive Triple-Seal rings to keep lubricant *in* . . . dust, dirt and water *out!*

On any job—under any load conditions—there is an SKF Pillow Block and Bearing which will make your equipment operate consistently at a lower cost.

Need some of these husky Pillow Blocks and Bearings? Write us for the name of your nearest stock-carrying Authorized SKF Distributor. 6500

SKF INDUSTRIES, INC., PHILA. 32, PA.

AND HERE'S THE ANSWER FOR HEAVY HAMMERMILLS, PAPER MILLS, STEEL MILLS, OIL FIELDS, ETC.

**TYPE SDAF**

Exceptionally heavy and rugged pillow block with self-aligning spherical roller bearing for severe loads.

● Send for Catalog 280, second edition.

## Triple-Seal Rings

Two split piston rings are located on each side of the bearing assembly. *Inner* rings serve as internal flingers while *outer* rings keep foreign substance from entering the pillow block. Because these rings are not locked to the shaft, they are free to locate themselves whenever shaft expansion occurs.

**SKF**

**PILLOW BLOCKS**

ENGINE BULLETIN
1472
the
190-GL
SIX
WAUKESHA
SIX CYLINDER ENGINES
for all Heavy-Duty Power-Driven Machinery
WAUKESHA MOTOR COMPANY • WAUKESHA, WIS.
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WAUKESHA



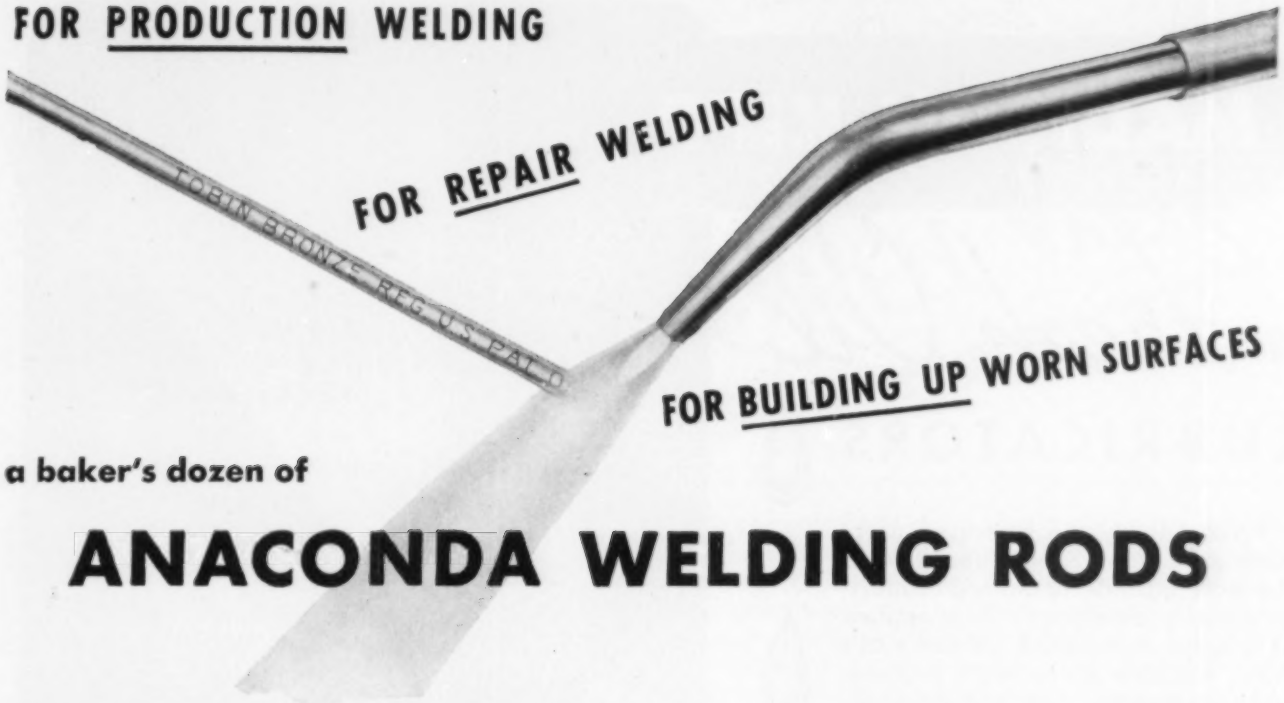
**190-GLU Standard Gasoline Power Unit**

**Send for this...**

Expanding a design already proved by arduous work-outs in industrial machinery on the job, the 190-GL Six is the result of more than 40 years of experience with a long line of engines of the same type. It's a heavy-duty 3¾ in. x 4 in., 265 cu. in. industrial six. Simple and accessible . . . rugged and rigid . . . streamlined to fit your equipment and packed with power to drive it. Built to keep from growing old—with wet cylinder sleeves and all other major parts *renewable*. Overhead valves! Advanced oiling system combines moderate pressure, metered-jet, and nozzle delivered spray. Waukesha centrifugal governor is gear driven, pressure oiled, completely enclosed. *Get the story in Bulletin 1472.*

**WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN**
NEW YORK TULSA LOS ANGELES

FOR PRODUCTION WELDING




FOR REPAIR WELDING

FOR BUILDING UP WORN SURFACES

a baker's dozen of

# ANACONDA WELDING RODS

| NAME OF ROD | APPROXIMATE COMPOSITION PER CENT | APPROX. MELT. PT. DEG. C.—DEG. F. | | SUGGESTED WELDING METHOD AND USE |
|---|---|---|---|---|
| ANACONDA COPPER 372 (PATENT NO. 2,220,464) | 98.85 Copper | 1075 | 1967 | Oxy-acetylene welding of copper. |
| DEOXIDIZED COPPER 939 | 99.9 Copper, deoxidizer present | 1083 | 1981 | Oxy-acetylene welding of copper. |
| SILVER BEARING COPPER 110 | 99 Copper, 1 Silver | 1078 | 1972 | Oxy-acetylene welding of copper. |
| SILICON COPPER 943 | 99.75 Copper, .25 Silicon | 1083 | 1981 | Oxy-acetylene welding of copper, copper to steel. |
| TOBIN BRONZE* 481 | 59 Copper, .50 Tin, remainder Zinc | 885 | 1625 | Oxy-acetylene welding of steel, cast iron, copper and its alloys, nickel and its alloys. |
| ECONOMY BRONZE* | Copper, Zinc, Tin | 885 | 1625 | Oxy-acetylene welding of steel and cast iron, etc. |
| ANACONDA 997 (LOW FUMING) | Copper, Zinc, Tin, Iron, Manganese, Silicon | 870 | 1598 | Oxy-acetylene welding of steel, cast iron, copper and its alloys, nickel and its alloys. Bearing surfaces. |
| MANGANESE BRONZE 984 | Copper, Zinc, Tin, Iron Manganese | 870 | 1598 | Oxy-acetylene welding of steel, cast iron, copper and its alloys, nickel and its alloys. |
| SUPER-NICKEL 826 | 70 Copper, 30 Nickel | 1225 | 2237 | Oxy-acetylene welding of Cupro-Nickel and steel. |
| EVERDUR 1010 | 96 Copper, 3 Silicon, 1 Manganese | 1019 | 1866 | Oxy-acetylene and carbon arc welding of Everdur, copper and copper alloys. Special applications to steel. |
| PHOSPHOR BRONZE 903 | 95.75 Copper, 4.00 Tin, .25 Phosphorus | 1050 | 1922 | Carbon arc welding of phosphor bronze and copper. Special applications to steel. |
| PHOSPHOR BRONZE 310 | 89.2 Copper, 10.5 Tin, .3 Phosphorus | 1000 | 1832 | Carbon arc welding of phosphor bronze, copper and copper alloys. Bearing surfaces on steel. |

*Reg. U. S. Pat. Off.

48161

ANACONDA
from mine to consumer

*Announcing* a "WHITE-BRONZE" Welding Rod

Anaconda Nickel Silver 828 is a 10% nickel welding rod for oxy-acetylene "white-bronze" welding of steel and cast iron. Information on welding procedure will be furnished on request.

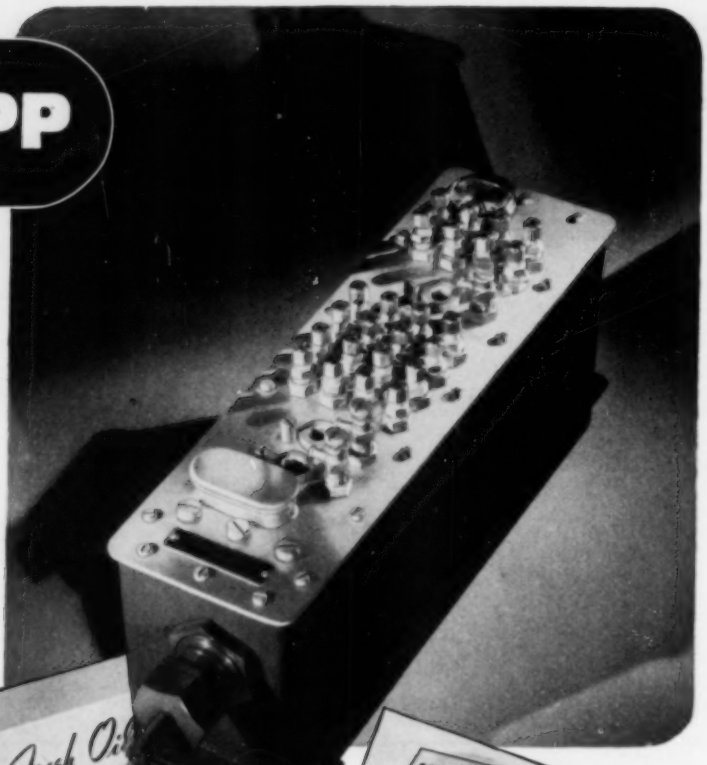
**THE AMERICAN BRASS COMPANY · General Offices: Waterbury 88, Conn.**

Subsidiary of Anaconda Copper Mining Company · In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

# MADISON-KIPP

## *Fresh Oil* LUBRICATORS

Fresh Oil, by the measured drop, from a Madison-Kipp Lubricator is the most dependable method of lubrication ever developed. It is applied as original equipment on America's finest machine tools, work engines, and compressors. You will definitely increase your production potential for years to come by specifying Madison-Kipp on all new machines you buy where oil under pressure fed drop can be installed.



## *Our 50th Year*

This long-time experience, we believe, has been the basis of sound progress. No better proof of progress can be offered than the fact that Madison-Kipp lubricators have been used as standard equipment by a long list of America's best manufacturers for 20 — 30 — 40 years and longer.

If you have an original equipment fresh oil lubricator problem, we will be glad to have an opportunity of presenting our solution.

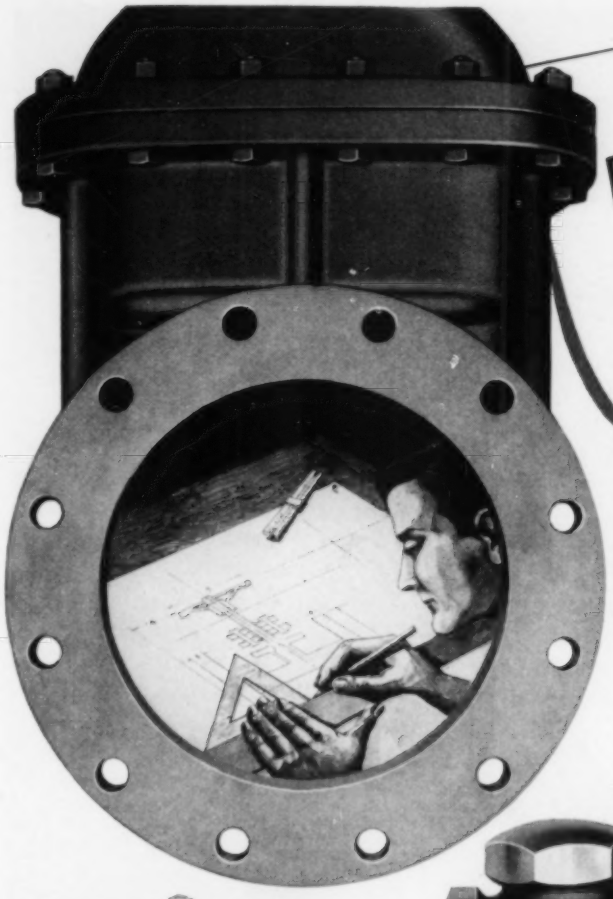
## MADISON-KIPP CORPORATION

**202 WAUBESA STREET, MADISON 4, WISCONSIN, U. S. A.**

ANCIENS ATELIERS GASQUY, 31 Rue du Marais, Brussels, Belgium, sole agents for Belgium, Holland, France, and Switzerland.

*WM. COULTHARD & CO. Ltd., Carlisle, England, sole agents for England, most European countries, India, Australia, and New Zealand.*

- *Skilled in* DIE CASTING *Mechanics*
- *Experienced in* LUBRICATION *Engineering*
- *Originators of Really High Speed* AIR TOOLS



# There's Precision Engineering in every POWELL VALVE

Powell makes valves by the thousands. We have to in order to satisfy the nation-wide demand.

But don't be misled! We know that quality often suffers through so-called "mass production" methods. So every Powell Valve from a standard small bronze globe to the most special design for corrosion resistance is given the most meticulous, individual attention. That's why Powell Valves have such an outstanding reputation for long life and dependable performance in every branch of industry. It pays to install Powell Valves.

**Fig. 95**—Bronze Dash Pot Check Valve for 200 pounds air working pressure. Designed for air compressor service. Has screwed ends, screwed-on cap and regrindable, renewable, wear-resisting bronze disc. Cushioning effect of plunger in dash pot makes seating of disc practically noiseless.

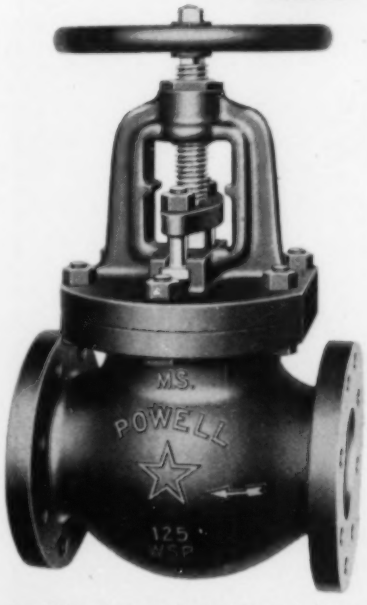



**Fig. 241**—Large 125-pound Iron Body Bronze Mounted Globe Valve. Made in sizes 2" to 16", inclusive. Has outside screw rising stem, bolted flanged yoke and regrindable, renewable bronze seat and disc.

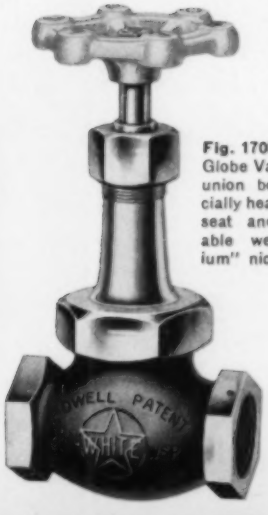



**Fig. 1708**—200-pound Bronze Globe Valve with screwed ends, union bonnet, renewable specially heat treated stainless steel seat and regrindable, renewable wear-resisting "Powellium" nickel-bronze disc.

**Fig. 1793**—Large 125-pound Iron Body Bronze Mounted Gate Valve. Made in sizes 2" to 30", inclusive. Has outside screw rising stem, bolted flanged yoke and tapered solid wedge. ➔

**The Wm. Powell Co., Cincinnati 22, Ohio**

**DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES**

# POWELL VALVES

# WHEN OTHER MACHINES ARE "MOVING UP"

## Bucyrus Walkers are MOVING DIRT

MUCH time ordinarily spent on moving about is converted into productive digging time when you put a Bucyrus-Erie walking dragline on your operations. The reason is simply that a Bucyrus-Erie cuts moving time by taking the most direct route. It can walk safely and surely in any direction, can change course by a mere swing of the revolving frame; no special steering mechanism is used — or needed. The machine is always ready to step off in any direction necessitated by working conditions—away from slides, along the edge of a steep bank, around obstructions, out of trouble's way.

With its exclusive rolling-cam walking traction, a Bucyrus-Erie takes every step safely, smoothly, quickly, cushioning the machine down. Rough ground seldom bothers because the walking shoes are mounted to pivot sidewise, conforming to any ground surface for a firm grip.

The walking efficiency of a Bucyrus-Erie gives you more time to use its "years ahead" digging efficiency!

24M47

BUCYRUS ERIE

Booms: 110 to 250 ft.
Buckets: 4 cu. yd. to 25 cu. yd.

**BUCYRUS-ERIE COMPANY**
SOUTH MILWAUKEE, WISCONSIN

# NEW

# Ingersoll-Rand TAMPING GUN

## USES 40% LESS AIR!

Slash your maintenance of way costs with the new MT-4 Tamping Gun, which uses *at least* 40% less air than the Tamping Guns *you have in use today*, and develops the same, or even more, tamping power!

This means *more* tamping guns operating from the *same* compressors; it means *more* work with *less* air! A brand new design gives *longer maintained* operating efficiency—air consumption stays low for the life of the tool!

The MT-4 Tamping Gun is built to run *longer* with *less* attention and *less* wear. Rugged, simple parts slash "time-outs" for maintenance!

An Ingersoll-Rand representative will be glad to demonstrate this revolutionary Tamping Gun on *your* road. See it—try it—you'll want to buy it!

Act at once—the Ingersoll-Rand MT-4 Tamping Gun is now ready for *your* trackmen—wire or phone your Ingersoll-Rand branch office today!

**Ingersoll-Rand**
*Originator of Mechanical Tamping*

*Look to the first—for the finest!*

**Ingersoll-Rand**
11 BROADWAY, NEW YORK 4, N. Y.

307-11

## YOU'LL FIND
# MAXIM SILENCERS

This photograph shows 15 steam jet Air Ejectors equipped with Maxim Silencers, some of the larger ejectors handling up to 9000 lbs. per hour of non-condensible gases at 8" Hg Abs.

The reason why you find Maxim Silencers so frequently in these more complicated installations is the same reason why you find Maxims in such a large percentage of all silencer installations . . . the reason is experience, more practical experience more research and development experience. Silencing has been our business for years.

If you need silencing for internal combustion engine exhaust or intake . . . compressor intake . . . vacuum pump discharge . . . steam blow-off . . . spark arrestor silencers . . . or heat recovery silencers, consult Maxim.

BULLETINS ON REQUEST

**THE MAXIM SILENCER COMPANY**
61 HOMESTEAD AVE. HARTFORD 1, CONNECTICUT

**BE SURE IT'S A**
# MAXIM

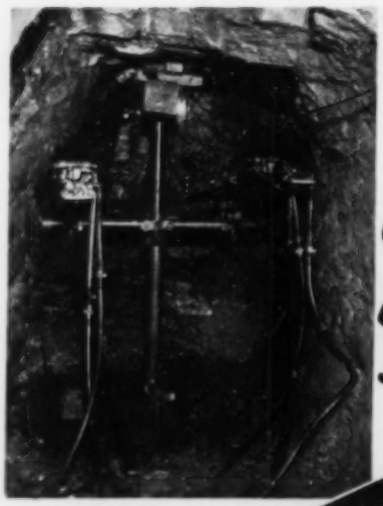
# *Get the water out of compressed air systems Automatically*

**with ARMSTRONG AIR TRAPS**

No. 71
Snap Action
Air Trap

STOP wasting air by manual blowdown of water from inter-coolers, after coolers, separators, receivers and drip points. Armstrong Air Traps installed at these points will automatically remove moisture —you save air and you save labor. Choice of ball float, snap action or inverted bucket models. Forged steel bodies available for high pressures. Get full details today. Write for Bulletin 143.

**ARMSTRONG MACHINE WORKS**
885 Maple St. • Three Rivers, Mich.



# "MINE KING"
*Standard of Quality*
## AIR HOSE
## *Offers Three Important Savings...*

Sizes 1½", ¾" and 1"

**1-** Longer service life . . . lower replacement costs Tough, wear-resistant cover protects carcass from absorption of sulphurous mine water.

**2-** Fewer couplings required. Availability in extra long lengths reduces number of intermediate connections.

**3-** Easier handling. Extreme flexibility facilitates drilling operations and coiling for transport.

*Contact Our Nearest Branch for Details and Prices.*

**GOODALL RUBBER COMPANY**
GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.
Branches: Philadelphia • New York • Boston • Pittsburgh • Chicago • St. Paul • Los Angeles
San Francisco • Seattle • Salt Lake City • Houston • Distributors in Other Principal Cities
Est. 1870

*This forging started right and will end right...*

## BECAUSE IT'S MADE WITH BASIC *Electric Steel*

● While the quality of the steel used is only one of many factors in producing exceptional steel forgings, it should be the first factor to consider in selecting your forging maker.

If your forging has a tough job to do, if it must stand up and give dependable performance over a long service life, if it must be capable of withstanding shock loads with high impact resistance, the character of the steel should be your primary consideration.

National Forge makes its own forging steel by the basic electric process—the process admitted to be superior for quality steel making. With the resultant finer grain structure and freedom from impurities, segregations and porosity, you can count on forgings with inherently greater strength.

Why not let us give you the technical reasons for specifying electric steel in your forgings . . . and also explain how the forgesmithing, heat treating and high precision finish machining are handled at National Forge. You'll buy better forgings if you let us place these facts in your hands.

NF

# National Forge

**AND ORDNANCE COMPANY**

*Irvine, Warren County, Pennsylvania*

STEEL MAKERS ☆ FORGESMITHS

HEAT TREATERS ☆ MACHINISTS

BURGESS SNUBBERS · BURGESS SNUBBERS

ASSURANCE OF A

# • Quiet intake

Don't put up with troublesome pumping noise at the intake of your compressor or blower, or the discharge from a vacuum pump. Install the correct size Burgess Snubber and eliminate the noise problem easily.

When you eliminate noise, you may also improve compressor operation, because a Burgess Snubber eliminates tuning pipe length to obtain best efficiency. It smooths the flow of air without choking or restricting air flow.

P.S. A Burgess-Manning Combination Air Intake Cleaner - Snubber is also available for air cleaning plus quieting. Write for full information.

BURGESS-MANNING COMPANY
749-P EAST PARK AVE., LIBERTYVILLE, ILLINOIS

BURGESS SNUBBERS · BURGESS SNUBBERS

MORE THAN MEETS THE EYE

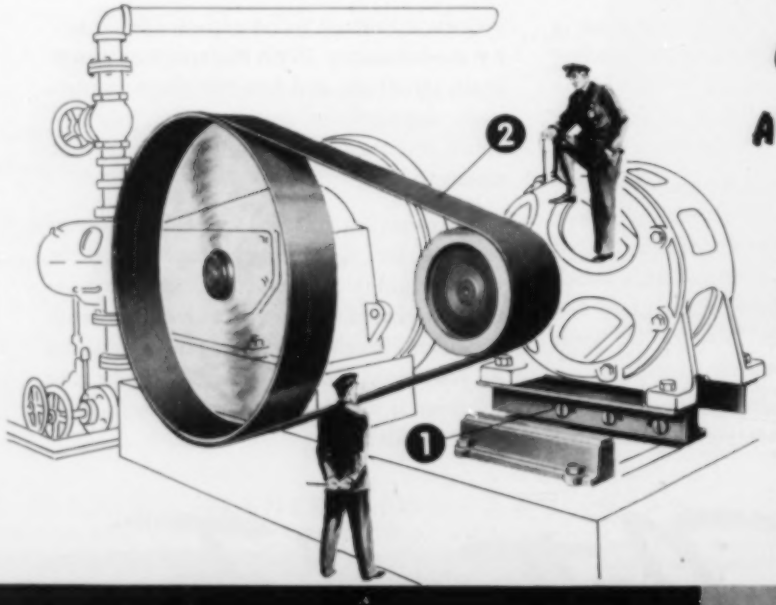
Just looking at the KOH-I-NOOR PENCIL doesn't begin to tell the story. It's when you actually use one that its superiority becomes immediately evident.

The KOH-I-NOOR Drawing PENCIL is made of the finest cedar grain and the finest lead. In every field where a pencil is used—art, engineering, designing or office work—KOH-I-NOOR is the choice.

*SEND FOR LEAFLET NO. 19*

KOH-I-NOOR
The RIGHT pencil for the RIGHT job
KOH-I-NOOR PENCIL COMPANY, INC., BLOOMSBURY, NEW JERSEY

TWO WATCHMEN GUARD THIS DRIVE AGAINST UNDUE WEAR




**NO. 1, AUTOMATIC TENSION CONTROL . . .** The pivoted motor base in this Schieren drive continuously maintains just the right belt tension. This makes the job as easy as possible for belt and bearings.

**NO. 2, PULLEY GRIP . . .** The clean, uniform surface of a Schieren Duxbak belt works with the base by providing a pulley grip that enables the belt to carry the load with less tension.

The Duxbak belt and the pivoted motor base work as a team to protect the compressor drive against undue strain.

Write for complete information on Schieren belting and the modern pivoted motor base or on any of the other Schieren products mentioned below.

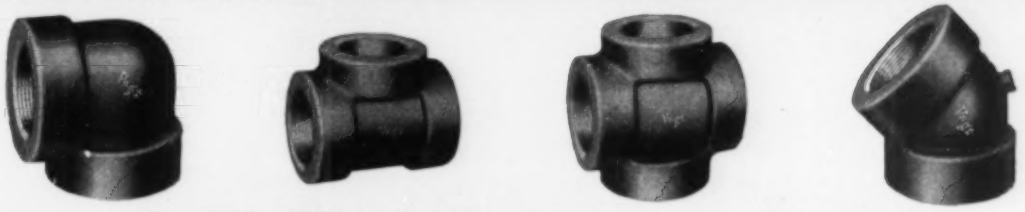
SC-29

CHAS. A. SCHIEREN CO., 35 Ferry St., New York 7, N.Y.
60 Front Street, W. Toronto, Ont.
Branch Offices in Chicago, Dallas, Denver, Detroit, Newark, New York, Philadelphia, Pittsburgh, Salt Lake City
*Tanners and Manufacturers of Leather Belting, Packings and Specialties Since 1868*

Leather Packings · Leather Belting · Leather Specialties

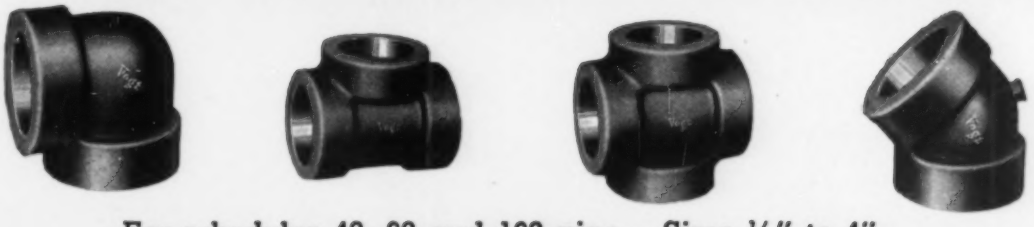
# STRENGTH

## for Safety and Long-Time Service



For 2000, 3000 and 6000 pounds service — Sizes 1/8" to 6"

## SCREW END TYPE



For schedules 40, 80 and 160 pipe — Sizes 1/8" to 4"

## SOCKET WELD TYPE

Vogt Ells, Tees, Crosses, etc., are forged from carbon steel or various alloys to meet specific operating conditions. Catalog F-8 will aid you in their selection and proper application.

Shocks and stresses imposed by high pressures and high temperatures are taken in their stride because Vogt fittings are uniform in structure, fine grained, and free from porosity . . . the superior product of laboratory controlled materials and giant forging hammers and upsetters. These properties also give higher resistance to erosive and corrosive conditions, thereby adding to service life expectancy in steam plants, petroleum refineries, chemical plants and related industries.

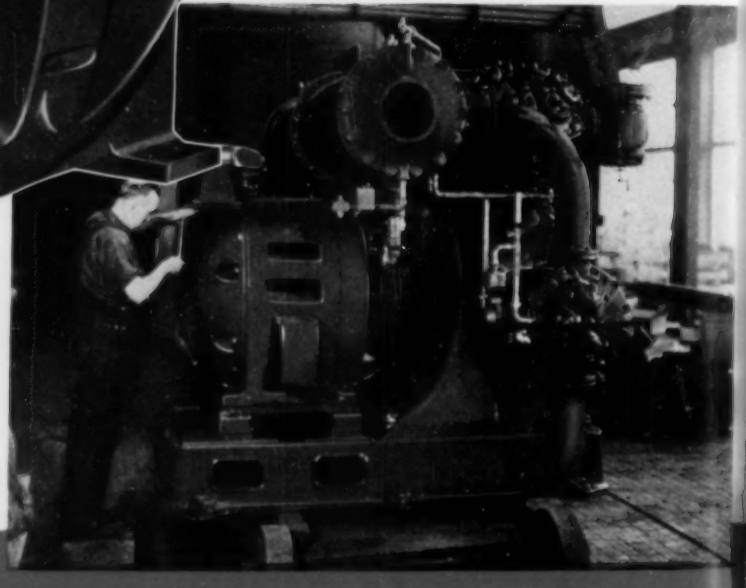
**HENRY VOGT MACHINE CO., INC.**
**Louisville 10, Kentucky**
BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

# Vogt DROP FORGED STEEL FITTINGS

# they're here... they're

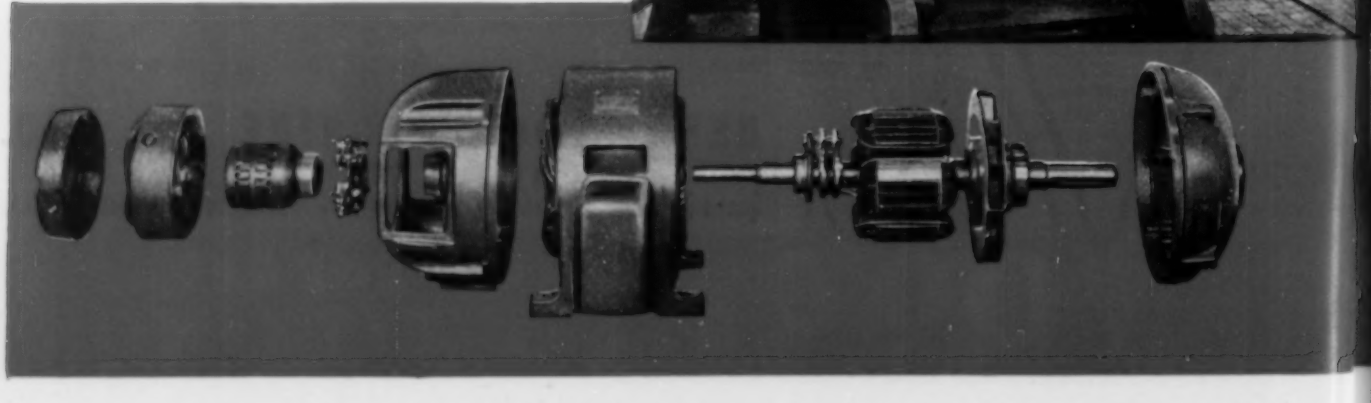
## NEW HIGH

A new TRI-CLAD Synchronous Motor typical of those machines rated at about 500 hp at 720 rpm.



A new TRI-CLAD High Speed Synchronous Motor, rated 250 hp at 600 rpm, direct coupled to an air compressor.

Exploded view of G-E TRI-CLAD machine.



# TRI-CLAD

REG. U.S. PAT. OFF.

## SPEED SYNCHRONOUS MOTORS AND GENERATORS

**These new synchronous motors and generators bring you the famous TRI-CLAD improvements:**

**Extra Protection Features!**—against physical damage—against electrical breakdown—against operating wear and tear.

**New Styling!**—smooth, rounded contours—baffled ventilating louvers—smooth-corners on exciters and conduit boxes.

Following General Electric design leadership, the new line of Tri-Clad synchronous motors and generators give you the same design features that made Tri-Clad motors so successful in more than a million and a half industrial applications.

Tri-Clad construction gives you protection where it counts. Frames and end shields with no openings above the center line—give protection against dripping liquids, falling objects, and accidental blows.

You get protection against electrical breakdown in normal operations. Proved insulating materials of the highest quality are used throughout. Small sizes (through frame 945) use Formex* wire for low voltage windings. Larger size coils are form wound and molded accurately to slot size.

Bearings are completely enclosed in cast iron with close running fits for long life with minimum maintenance. Deep oil reservoirs insure adequate lubrication with clean, cool oil.

You can get synchronous motors in the new Tri-Clad design in ratings from 20 hp to 1000 hp at 60 cycles, speeds from 514 to 1800 rpm. Synchronous generators are available from 12½ to 1250 kva. Direct connected exciters are available for any rating.

About ten years ago, the Tri-Clad design was introduced to combine the important features demanded by industry. Since then, it has been further improved with additional refinements—all of which have been incorporated in this new line of synchronous motors and generators.

For more information on how you will benefit from Tri-Clad construction in your synchronous motor and generator installations, contact your nearest G-E sales engineer. For detailed construction features, write for GEA-5113 (Motors) or GEA-5125 (Generators). *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

*Reg. U. S. Pat. Off.

Typical TRI-CLAD High Speed Generator with direct-connected exciter.

GENERAL ELECTRIC

770-1

# PLAY SAFE!

BUY **LE-HI** HOSE COUPLINGS FOR HIGH PRESSURE AIR LINES

Construction men take no chances. They know that every length of hose and every hose coupling is a vital factor in the safety of both men and equipment.

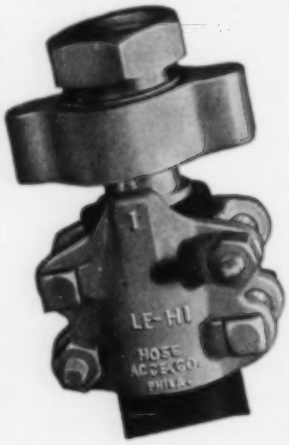
When you buy LE-HI, you buy *the safety you must have*—because there are no *safer, tougher* hose couplings on the market than LE-HI. . . .

LE-HI Series 150-B. The only Universal Type Hose Coupling with the patented "Safety-Locking" feature that positively prevents accidental uncoupling. Especially designed for compressed air service.

**SAFER,** because of LE-HI's advanced design . . . shanks and clamps that won't "blow off" . . . LE-HI Series 150-B, the only Universal Type Couplings with the patented "Safety-Locking" feature that positively prevents accidental uncoupling. . . .

**TOUGHER,** because of rigid standards of quality and workmanship . . . *extra-heavy construction* to take the beating of a tough business—and keep on taking it!

Construction is booming everywhere. Be ready for your part in the program with *safe, efficient* equipment. And be sure that every air line has LE-HI—the SAFER, TOUGHER Hose Couplings!




LE-HI Series 400-G or W. Female Coupling with I.P.T. Spud Sizes ¾" and smaller furnished with two-bolt clamp; 1" and larger with four-bolt clamp.

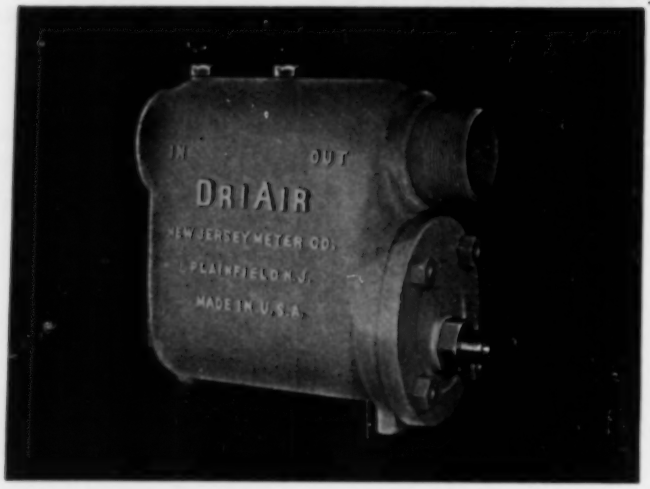
*Sold Only Through Leading Distributors and Rubber Manufacturers*

LE-HI HIGH and LOW PRESSURE HOSE COUPLINGS

*LE-HI MAKES A GOOD CONNECTION*

**HOSE ACCESSORIES COMPANY**
**2716 NORTH 17th STREET • PHILADELPHIA 32, PA.**

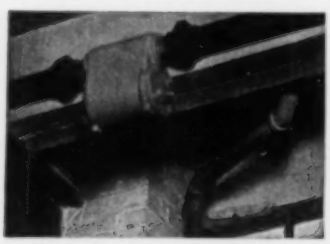
# DEPENDABLE PNEUMATIC SERVICE




## WHEN EQUIPMENT IS PROTECTED BY

# DRIAIR

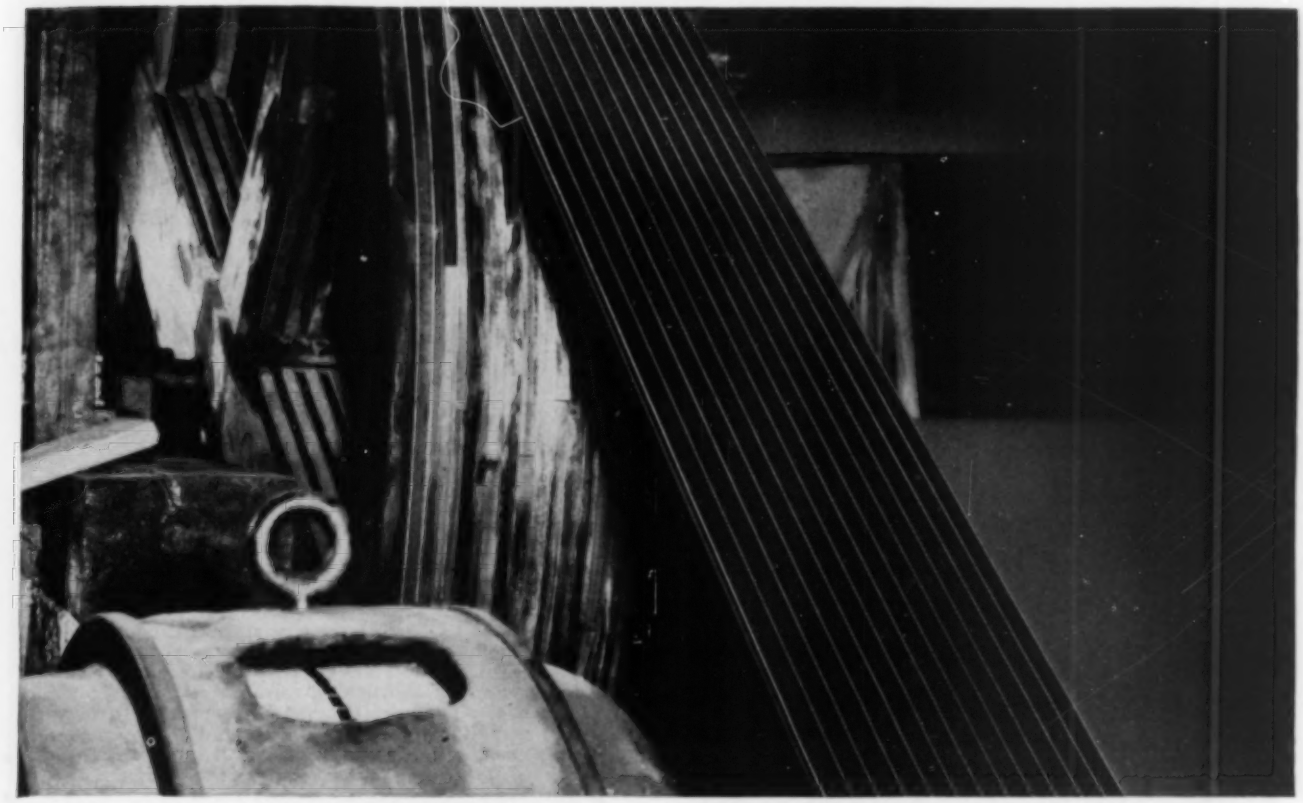
## A COMPLETE SELF-CONTAINED UNIT



**DriAir may be installed by suspending it from the piping, without any other support, or may stand on the floor near equipment being protected**

DRIAIR speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper – resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request.

**NEW JERSEY METER COMPANY**
**PLAINFIELD, NEW JERSEY**



# Saves $1,200 a year on "Crack-the-Whip" Drive

"Cracking the Whip" is fun for the riders of a Pennsylvania Amusement Park, but it's one of the toughest drive applications. The fast starts, rapid accelerations and sudden stops cause ordinary belts to slip . . . burn and wear through.

Take the case of this Park Owner. During the 1946 park season, his "Whip" wore out 3 of the 40-foot, original-type belts. He had to replace them at a cost of $400 each.

Then he called the Dayton V-Belt Distributor. His problem was studied. The power, speed and space limitation analyzed. Recommendation: Use the old wood—flat driven pulley, install standard Dayton V-Belts and Dayton Motor V-Pulleys. Nothing "special" required. Result: After two years, no slippage, no burning, no wear through. $1,200 a year saved.

When it comes to transmitting power, Daytons can do it better and save you money. Your local Dayton V-Belt Distributor has specialized knowledge and complete stocks.

For a better, more profitable solution to your drive problem, call your local Dayton V-Belt Distributor.

**THE DAYTON RUBBER COMPANY**

Main Office and Factory: Dayton 1, Ohio

Branch Offices: Atlanta, Boston, Chicago, Cleveland, Dallas, Detroit, Los Angeles, Minneapolis, New York, Philadelphia, St. Louis

**V-Belt Buyers! A leading mill supply house near you offers specialized Dayton V-Belt service. Look for the name under the trade name heading "Dayton V-Belts" in the yellow pages of your telephone directory.**

**Dayton Rubber**

THE MARK OF TECHNICAL EXCELLENCE IN NATURAL AND SYNTHETIC RUBBER

# MADESCO BLOCKS stand the gaff

**wire rope blocks**

**Madesco Auto Lub bronze-bushed blocks**

Madesco Auto Lub blocks are constructed for heavy duty, scraper, excavating and cable-way service. For details, write, stating rope size, working load and type of fitting. Describe any unusual working conditions.

*Send for complete catalog . . .*

**MADESCO**
**TACKLE BLOCK COMPANY**

*A quarter century of service*

EASTON, PENNSYLVANIA

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**FOR *Faster* PRODUCTION!**
***Precision* CONTROL!**

—WITH LOCKING FEATURE

FOR PANEL MOUNTING—

**HANNIFIN AIR WARDEN REGULATOR**

Here's the new air pressure regulator that gives you everything you want for FASTER PRODUCTION, PRECISION CONTROL! It's the Hannifin "Air Warden" for use on all kinds of air operated equipment. You get fast, dependable action; quick build-up to desired pressure. Pressure setting repeats exactly regardless of fluctuating flow conditions. It's easy to back-off pressure without exhausting line — saves air! All models available in ⅜" and ½" sizes. For primary pressures to 150 p.s.i. and for reduced pressures of from 5 to 125 p.s.i. Ask for latest bulletin. HANNIFIN CORP., 1101 S. Kilbourn Ave., Chicago 24, Illinois.

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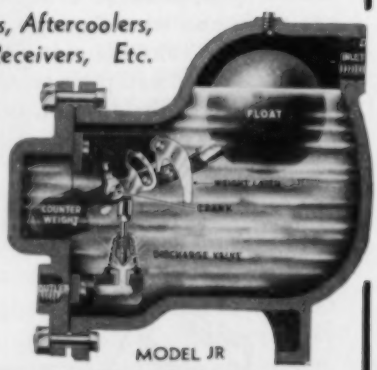
*6 Ways Nicholson Units*

# CUT AIR TRAP MAINTENANCE

*On Intercoolers, Aftercoolers, Separators, Receivers, Etc.*

Nicholson weight-operated air traps are increasingly recognized for the way they cut "down time" and maintenance work. Below are six reasons why. Three types; for pressures to 1500 lbs.



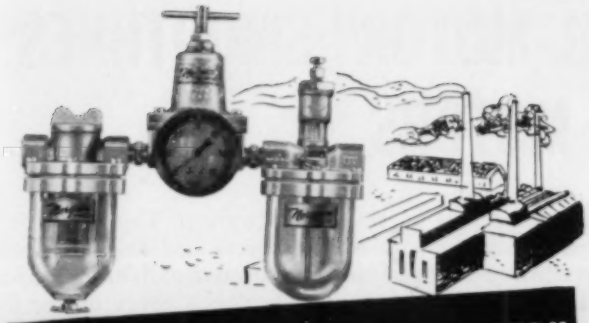

MODEL JR

1) Leak-proofed by positive fluid seal over valve.
2) Not dependent on buoyancy or weight of float.
3) Non wire drawing.
4) Rugged, to take unavoidable abuse.
5) Not easily affected by dirt, pulsation, etc.
6) Of stainless steel where it counts.

*Catalog 448 or see Sweet's*

**W. H. NICHOLSON & CO.** 180 OREGON STREET WILKES-BARRE, PA.

*Valves ★ Traps ★ Steam Specialties*



## WHEREVER AIR IS USED IN INDUSTRY

. . . there is a definite need for a NORGREN LUBRO CONTROL UNIT! Stops dust and moisture. Regulates surging air pressures with less pressure drop than conventional regulators. Lubricates every moving part of air tools and cylinders by injecting oil fog directly into air lines. Gives lasting protection when tool is idle. Write C. A. Norgren Company, 222 Santa Fe Drive, Denver 9, Colo.

**Norgren**

## A NEW PRESSURE SWITCH FOR AIR COMPRESSORS AND WATER PUMPS

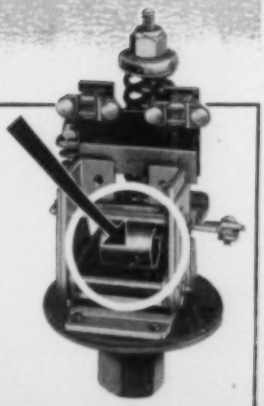
CLASS
9013 • TYPES GHG and GSG

**"POWER HOUSE"**
***Snap-Action Spring***

provides powerful contact snap action and complete valve opening with air compressor switches at all ranges of operation—60 lbs. through 200 lbs. P.S.I.

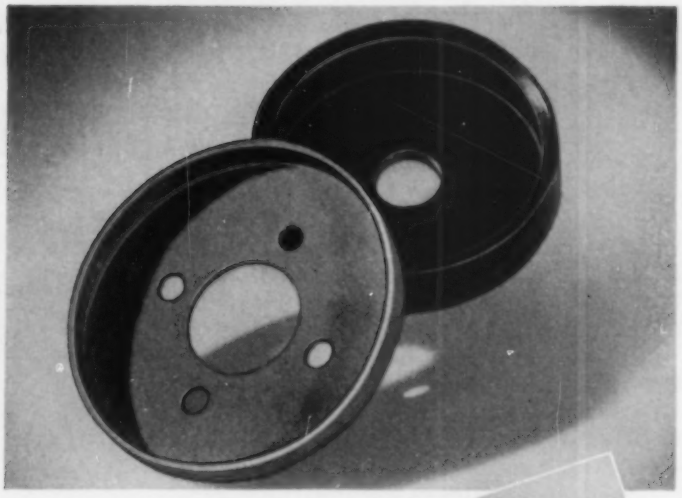
*Write for Bulletin* **9013-G**

Square D Company, 4041 N. Richards St.
Milwaukee 12, Wis.

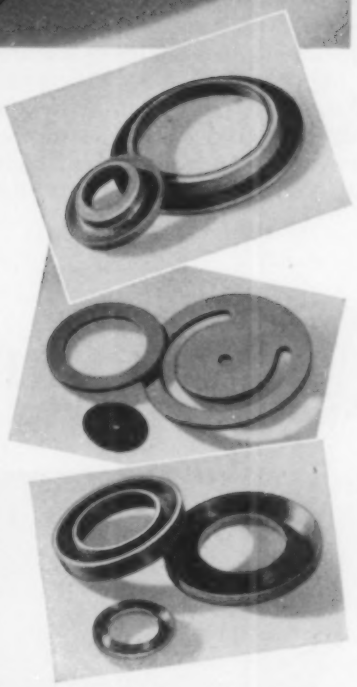


**SQUARE D COMPANY**

DETROIT MILWAUKEE • LOS ANGELES



## *For Severe Leather Packing Service*



Garlock BITAN* Leather Packings are tanned and treated by an exclusive Garlock process for the most severe leather packing applications. They operate satisfactorily at higher temperatures and higher pressures than leathers of standard tannage and treatment.

In filling each order, the leather is properly tanned and treated for the particular service for which the finished product is to be used. All types or forms including: Molded Cups, "U" and "V" Packings, Flange or Hat Packings, Gaskets, Washers, and Discs. All sizes. Write for descriptive folder.

THE GARLOCK PACKING COMPANY
PALMYRA, N. Y.
In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

*Reg. U. S. Pat. Off.

# GARLOCK *Bitan** LEATHER PACKINGS

# NEW METHODS BRING "SPECIAL-MOTOR" SMOOTHNESS TO STANDARD MOTORS

Motors have been made in much the same way for many years, until Westinghouse—with many years of leadership in a-c motor developments—departed from "tradition" in electric motor concepts, and built the Life-Line.

Motor-making traditions have been broken by the basketful. Users were surveyed to find what they wanted in standard motors that they were not getting. Life-Line motors were designed and built from scratch—by new methods and new tools in a totally new plant—to include these features.

Quieter operation was one feature motor users asked for. It's important in many places—fans, blowers, air conditioning. Life-Line motors provide it. Life-Line ventilating design limits "windage" noise. New manufacturing techniques that insure absolute alignment and accuracy of fit, reduced vibration. The result is a *standard* motor with the quietness and freedom from vibration evidenced in the dramatic demonstration shown opposite. Modern tests check every motor for accuracy in manufacture.

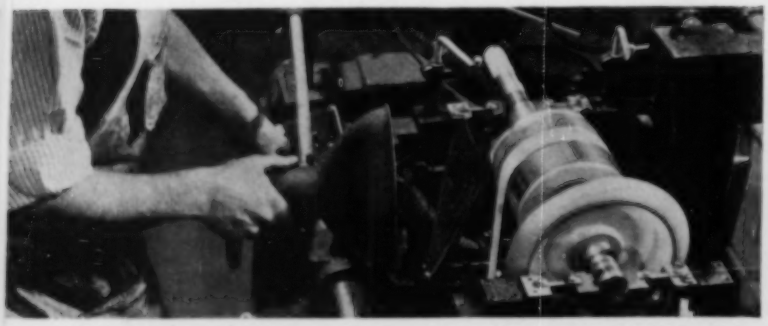
You will want full details on other Life-Line features—its solid steel construction—freedom from lubrication for 5 years or longer—new compactness and light weight. Life-Line motors, now built in sizes from 1-15 hp, are available in standard and near-standard types from stock. Other sizes and types—up to 200 hp—will soon be changed over to modern Life-Line design. Check your nearest Westinghouse office for deliveries—or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21457

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Life-Line motors

**MEASURED—WITH AIR** New extreme accuracy for checking diameters of shafts and bearing bores is made possible by this precision gauge. Size is checked by any variations in air stream escaping between the part being checked and the master gauge.



**EVERY UNIT BALANCED.** *Every* Life-Line rotor—not random samples—is balanced on a Dynetric balancing machine* to insure maximum possible freedom from vibration of every unit.

*Reg. U. S. Pat. Off.

**MOTOR "ASTHMA" CHECK.** Sounds that shouldn't be there don't get by this "noise detective". Audiometer tells noise wave length; sound level meter (left) checks decibel rating; sound analyzer (right) tells the relative amount of different frequencies resulting.

Life-Line
SMOOTH? HERE'S PROOF! Coin balanced on edge on a Life-Line motor remains undisturbed as motor is started, runs and stops—dramatic evidence of Life-Line's freedom from vibration and resulting noise!

# YOU CAN GET THESE FEATURES

I-R Chemical Pumps for capacities to 4000 gpm . . . heads to 200 ft.

*"Ircamet"* is a special corrosion-resistant alloy, containing high chromium and nickel with molybdenum and low carbon. Other materials are available for special services.

The *"Leakollector"* (standard on all I-R Chemical Pumps) is a new I-R patented gland which collects, or by-passes for disposal, all leakage that may occur from the stuffing box.

All I-R Chemical Pumps can be equipped with the *"Cameron Shaft-Seal"* . . . the modern solution to stuffing box problems.

Ask your nearest I-R engineer for more complete information about these important and proven features . . . all of which can be found *only* in Ingersoll-Rand Chemical Pumps.

## *Only in* INGERSOLL-RAND CHEMICAL PUMPS

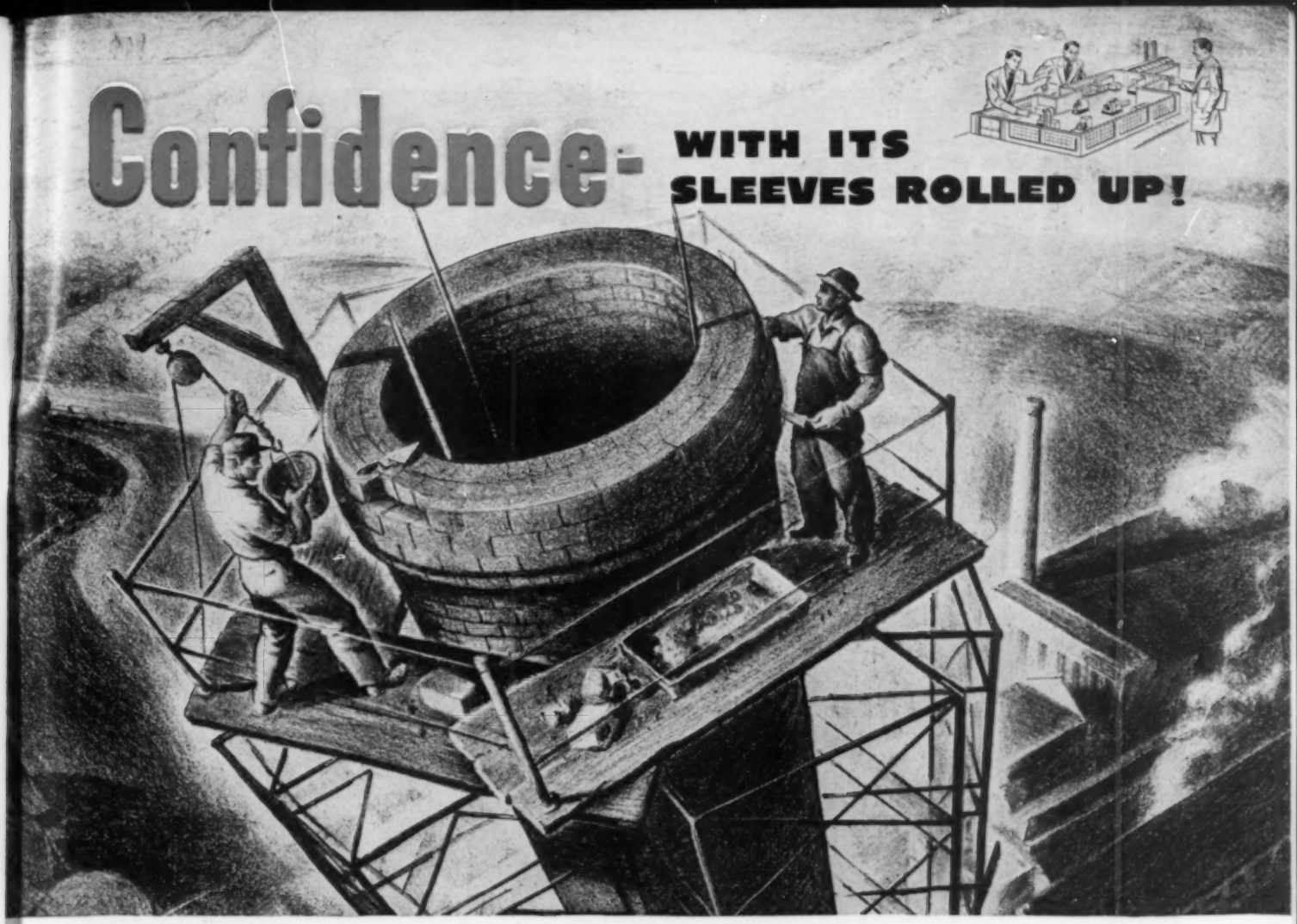
AIR TOOLS • COMPRESSORS • ROCK DRILLS •
CENTRIFUGAL PUMPS • TURBO BLOWERS
OIL & GAS ENGINES • CONDENSERS

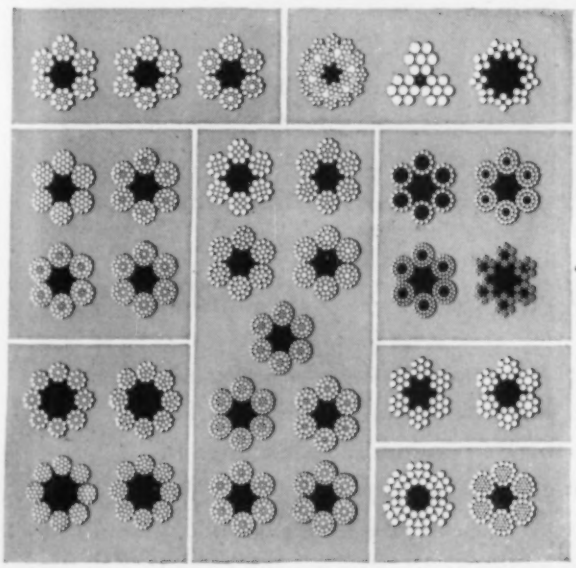
# Ingersoll-Rand

CAMERON PUMP DIVISION . . . 11 BROADWAY, NEW YORK 4, N. Y

313-10

# Confidence- WITH ITS SLEEVES ROLLED UP!





STRAIGHT AND STALWART, every factory stack is a towering symbol of man's faith in the future... industry's confidence in its ability to create and to expand production for better living and a richer world.

With confidence like that, Roebling has pioneered in developing and making an extraordinary range of products indispensable to industry. And the confidence that its products and engineering skill have earned in every industrial field is one of Roebling's most valued assets. Every Roebling employee is striving to safeguard that confidence by making products and rendering services that are of maximum utility to you.

## YOU CAN'T GO WRONG WITH THE RIGHT WIRE ROPE

EVERY TYPE of Roebling Wire Rope is right for certain service. But that's not enough... the important thing is that you choose the one rope that's *right* for your own job... the rope with the right balance of strength, flexibility, fatigue and abrasion resistance to give real economy over a long period of use.

Your Roebling Field Man will gladly study your requirements, and you can have full confidence that the rope he recommends will give you top returns per dollar. Whatever type it is, preformed or non-preformed, it will have behind it Roebling's unequalled experience in research, development and manufacturing the finest wire products that can be made.

Call or wire the nearest Roebling branch office.

JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
*Branches and Warehouses in Principal Cities*

**A CENTURY OF CONFIDENCE** **ROEBLING**

JAR ROEBLING

*★ WIRE ROPE AND STRAND ★ FITTINGS ★ SLINGS ★ SUSPENSION BRIDGES AND CABLES ★ AIRCORD, AIRCORD TERMINALS AND AIR CONTROLS ★ AERIAL WIRE ROPE SYSTEMS ★ ELECTRICAL WIRE AND CABLE ★ SKI LIFTS ★ HARD, ANNEALED OR TEMPERED HIGH AND LOW CARBON FINE AND SPECIALTY WIRE, FLAT WIRE, COLD ROLLED STRIP AND COLD ROLLED SPRING STEEL ★ SCREEN, HARDWARE AND INDUSTRIAL WIRE CLOTH ★ LAWN MOWERS*

# HERCOMITES

# GELAMITES

## Why they are replacing older-type explosives

High cartridge count, Hercomites* and Gelamites* are delivering explosive energy equal to that delivered by the older-type Extra Dynamites and Gelatins they are replacing . . . at considerable savings in cost. Hercomites and Gelamites are easy to handle. They are packed in handy Tamptite* cartridges that make "slitting" unnecessary and save powder. Tamptite cartridges are standard for Hercomites and Gelamites in all sizes regularly used for mining.

Write today for our new explosives booklet, "Hercomites and Gelamites for Lower Blasting Costs."

**HERCULES POWDER COMPANY**

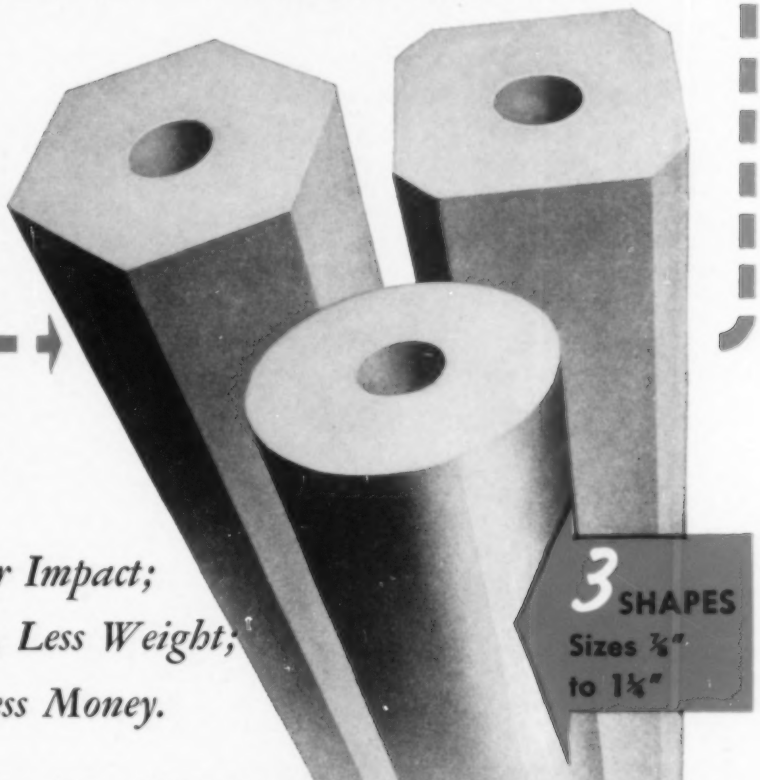
INCORPORATED

932 King Street, Wilmington 99, Delaware

*REG. U. S. PAT. OFF.

# *Here is*
# CRUCIBLE'S

## NEW "Park A" Alloy • hollow drill steel




*Offers Longer Life Under Impact;*
*Permits Smaller Sections, Less Weight;*
*Makes More Hole for Less Money.*

CRUCIBLE'S new "Park A" Alloy offers a big saving over the use of carbon drill steel in the cost of drilling with stud jackbits. Recent tests show savings in steel cost alone to be in excess of 30%. In addition, "Park A" Alloy permits maximum drill speeds; has longer life with stud jackbits; enables you to use a smaller section with the same size bit.

Crucible's new alloy hollow drill steel has been thoroughly tested, conforms to I-R Specification 139, and is recommended for jackstud insertion. Mill tests and inspections insure high quality and uniformity of every lot as to hole centering, size, and section accuracy, fatigue strength, stiffness, analysis, and structure.

Ask your Crucible CRUSCA drill steel salesman about "Park A" Alloy hollow drill steel. Get more hole for less money.

IMPORTANT! *New Data Sheet on Crusca "Park A" Alloy Drill Steel Just Printed! Write for Your Copy!*

**CRUCIBLE STEEL Company of America**

"FULL-RANGE" QUALITY STEELS for INDUSTRY

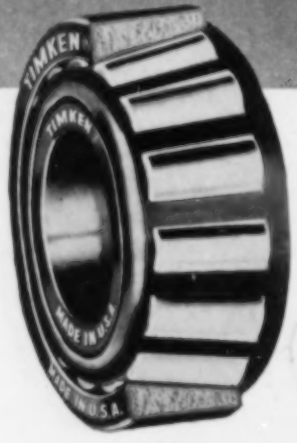
HIGH SPEED • TOOL • STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

Chrysler Building, 405 Lexington Ave., N.Y. 17, N.Y.

Branches, Warehouses, and Distributors in Principal Cities. Consult your Telephone Directory or Thomas' Register for Nearest Office

# Get Anti-Friction Compressor Performance *at its best*

*Ingersoll-Rand 15 x 11 type ES air compressors equipped with Timken Tapered Roller Bearings installed in glass manufacturing plant.*




## BUY "TIMKEN® BEARING EQUIPPED"

Merely specifying anti-friction bearings is no assurance of getting *all there is* in anti-friction performance; this depends on the *kind* of anti-friction bearings used.

When they are Timken Tapered Roller Bearings you will get incredibly smooth operation; simplified lubrication; radial, thrust and combined load capacity; full protection against wear; positive, permanent crank shaft alignment; and because Timken Bearings are manufactured of Timken Fine Alloy Steel they have greater endurance under all operating stresses. See that you have them in your new equipment. Look for the trade-mark "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Cable address "TIMROSCO".

**TIMKEN**

TRADE-MARK REG. U. S. PAT. OFF.

**TAPERED ROLLER BEARINGS**

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION ✳